ADM6.9/1980/v.3
c.1

COLORADO STATE PUBLICATIONS LIBRARY
3 1799 00178 3398

STATE OF COLORADO
1876

ADP MASTER PLAN

Volume III

January, 1980

REVENUE DATA PROCESSING
TASK FORCE STUDY

Richard D. Lamm, Governor

Lee White, Executive Director

Department of Administration

DEPARTMENT OF REVENUE
DATA PROCESSING
TASK FORCE
STUDY

December, 1979

1980 STATE OF COLORADO **ADP MASTER PLAN**

Digitized by the Internet Archive
in 2016

https://archive.org/details/adpmasterplan1980colo_1

STATE OF COLORADO

DIVISION OF AUTOMATED DATA PROCESSING
Department of Administration

1575 Sherman Street, Room 110
Denver, Colorado 80203
Phone (303) 839-2641

1876

Richard D. Lamm,
Governor

Lee White,
Executive Director

Robert J. Miller,
Director

MEMORANDUM

TO: ALAN CHARNES, EXECUTIVE DIRECTOR, DEPARTMENT OF REVENUE
LEE WHITE, EXECUTIVE DIRECTOR, DEPARTMENT OF ADMINISTRATION

FROM: THE DEPARTMENT OF REVENUE DATA PROCESSING TASK FORCE

SUBJECT: FINAL REPORT AND RECOMMENDATIONS FOR THE REVENUE DATA PROCESSING TASK FORCE STUDY (ADP MASTER PLAN, VOLUME III, JANUARY, 1980)

Attached is a copy of the report of the Department of Revenue Data Processing Task Force Study.

The Study was planned and organized to accomplish the following objectives:

1) Determine the Department of Revenue's ADP application workload requirements and computer hardware processing needs for the next five years.

2) Determine the feasibility of providing computer backup capability for administrative processing.

3) Determine the need and desire for a Financial Management Computer Center.

The Task Force was unanimous with the findings, conclusions and recommendations contained in the report.

We are grateful for the cooperation of those personnel in the Department of Revenue and Division of ADP who provided the Task Force with information and advice.

TASK FORCE MEMBERS:

Philip Rolf
Philip Rolf
Systems Analyst Manager
Department of Revenue

Ronald Parker
Ronald Parker
Statewide ADP Consultant
Division of ADP

APPROVED BY:

Robert J. Miller
Robert J. Miller
Director of ADP
Division of ADP

Norman Taylor
Norman Taylor
Director of Administration/Data Processing
Department of Revenue

TABLE OF CONTENTS

PAGE NUMBER

CHAPTER I: SUMMARY 1.1
- o Overview
- o Purpose
- o Operation Consideration
- o Technical Consideration
- o Computer Backup
- o Short Fall in Computer Resource
- o Financial Computer Center
- o Recommendations

CHAPTER II: BACKGROUND 2.1
- o Introduction
- o General Financial Management Study
- o Interim Solution to Department of Revenue Short Fall in Computing Resources
- o Administration of Justice Study
- o Re-Assess Department of Revenue's Computer Workload Requirements
- o Purpose and Scope
- o Assumption
- o Methodology and Procedures

CHAPTER III: FINDINGS 3.1
- o Introduction
- o Organization
- o Hardware Configuration
- o ADP Applications
- o Programming Languages Utilized
- o Current Level of Service
- o Transaction Statistics
- o Workload Projections
- o Relative Computer Power
- o Computer System Performance and Capacity
- o Computer Backup
- o Operating Systems
- o Financial Computer Center

TABLE OF CONTENTS

PAGE NUMBER

CHAPTER IV: CONCLUSIONS AND RECOMMENDATIONS 4.1
- Introduction
- Organization
- Operational Considerations
  - Data Entry
  - Software
- Technical Consideration
- Computer Backup
- Hardware Consideration
- Financial Computer Center

APPENDIX 5.1

A - Relative Computer Power
B - Department of Revenue Organization
C - Computer System Configuration and Data Communications Network
D - Current ADP Applications
E - Division of ADP Computer Service Level Standards
F - Department of Revenue Computer Downtime

DEPARTMENT OF REVENUE
DATA PROCESSING
TASK FORCE
STUDY

OVERVIEW

This report is an outgrowth of the approved 1977 ADP Master Plan and the pursuing 1978 General Financial Management Task Force Study report (ADP Master Plan, Volume II, January, 1978, entitled General Financial Management Task Force Study). The 1978 ADP Master Plan report recommended the consolidation of three computer centers into two computer centers; namely, the General Government Computer Center and Financial Computer Center (Revenue). The General Government Computer Center was created in July, 1978 as a result of the study. Higher administrative and legislative priorities prevailed causing the establishment of the Financial Computer Center to be postponed.

The General Government Computer Center consolidation provided the Department of Revenue with additional computer resources. This addition provided an interim solution to the Department of Revenue's FY 1978-79 short fall in computer power. Executive concern about fiscal reality has brought about the need to determine the current impact of the interim computer upgrade on the Department of Revenue's application workload.

PURPOSE

The major objectives of the task force was to determine the Department of Revenue's computer processing needs for the next five years, the feasibility of providing computer backup capability for administrative processing and determine the need for a Financial Management Computer Center.

OPERATIONAL CONSIDERATIONS

The three major problems facing this country today, as defined by the President's Business Advisory Committee, are productivity, inflation, and energy. Executives, legislators and managers have an opportunity, through the implementation of the recommendations of this report, to be instrumental in providing the Department of Revenue the capability to bring their data processing to the "State-of-the-Art" and to reduce eight operational positions, once the plan is fully implemented.

Revenue's data processing has reached a stage in their development where changes need to be made to increase productivity, to provide better service, and update their programming and operational technology.

Revenue's continued use of a low level programming language, as their main programming language, has hindered their ability to be more responsive to the end user and the capability to progress with the industry. Higher level languages better meet the increasing demands of administrators and end users for shorter development time and more timely information, and helps to control growing personnel and program development costs.

Terminal response time and computer processing time could be improved by discontinuation of three programming practices. The practices of using batch programs modules for both batch and on-line file management may cause inquiries to go through unnecessary routines in obtaining the information. CBI's practice to continue to store inquiries on disk for Revenue's computer even after Revenue's computer is no longer available for processing creates the need to process a large number of transactions which are no longer needed by the law enforcement agencies. Revenue could do more to improve the computer to computer interface with CBI and improve their own processing by changing the on-line drivers license program to a multi-thread program where more than one transaction at a time could be processed.

Revenue presently employs approximately 70 full time employees for their on-line data entry activity, known as Video 370. This activity may have been a good practice twelve years ago when it was first installed, however, today data processing industry has made advancements in data entry equipment where more efficient and economical methods have been developed. The current methods have proven to be more productive because of better terminal response time, more systems availability, and better use of the computer resources.

TECHNICAL CONSIDERATIONS

The State of Colorado has grown and developed at a fast pace over the last ten years. Likewise, the data processing industry has rapidly advanced in technology and capability. The State's growth and development has a direct affect on Revenue's data processing workload and capability to be responsive.

Revenue, to keep pace, needs to change their computer operating system. The migration to a full operating system (OS) should provide the capability to better manage the resources, increase systems throughput, improve security, reduce operator involvement and improve productivity of operation personnel. The State has the opportunity to reduce 4.0 operational positions once OS is implemented and the capability to consider computer backup for administrative processing.

COMPUTER BACKUP

The Department of Revenue Computer Center and the General Government Computer Center comprises the largest percentage of the State's administrative processing. The loss of either one of these computer centers for a prolonged period of time during critical processing would result in a very high risk for the State. Physical separation of the primary computer center and the backup computer center ensures that both locations will not be crippled by the same hazard or prevailing condition. In addition, physical separation can be further enhanced by obtaining electric power and data communications from separate substations and exchanges, respectfully. Once Revenue has completed the migration to a full operating system and additional data communication facilities have been developed, then the State has reached the point where critical on-line applications could be considered for backup.

SHORT FALL IN COMPUTER RESOURCES

Revenue's present computer system does not possess the needed resources to provide backup capability for the General Government Computer Center's critical on-line applications. Revenue's projected application workload requirements in fiscal year 80-81 will exceed the projected available processing hours for the present computer configuraion. In addition, Revenue's on-line computer exceeded the established practical control limits, 46% of the time on prime shift. This short fall in computer power and deteriorating service, coupled with the need to update their operating system and to provide administrative computer backup capability indicates Revenue should upgrade the present computer to a larger scale computer. The installation of a single, larger computer will provide the State the opportunity to reduce the operations staff by an additional 4.0 FTE.

FINANCIAL COMPUTER CENTER

The Financial Computer Center concept was an outgrowth of the 1977 ADP Master Plan and was conceived by data processing and consisted of transferring the central activities of accounting, treasurer, personnel, payroll, purchasing and budgeting to the Department of Revenue's computer center.

Revenue's immediate needs to develop new applications for cash management and accounts receivable coupled with the additional needs to update their computer operations to the State-of-the-Art processing makes the transfer of the central applications a high risk and more costly at this time. In addition, the consolidation could hinder the progress of the central agencies to complete the development of their data base management systems, to interface the present personnel and payroll systems, and the defining of future requirements and needs.

RECOMMENDATIONS:

The task force believes the following recommendations should provide the capability to increase employee productivity and performance, and provide a more efficient and economical means of operation. The approach to implementation of the majority of these recommendations is by phasing out these outdated practices. This approach does not result in short term benefits but should produce long term savings. Management must be aware that front end cost will occur in order to achieve the objectives. Non-productive hours will be spent in the educational and learning curve process. The "State-of-the-Art" objective will take time to achieve. A planned systematic approach needs to be developed so that long range savings can be obtained.

RECOMMENDATION 1

REVENUE NEEDS TO UPGRADE THEIR PRESENT COMPUTER CONFIGURATION TO A LARGER SCALE CENTRAL PROCESSING UNIT (CPU).

RECOMMENDATION 2

REVENUE SHOULD MIGRATE TO A FULL OPERATING SYSTEM.

RECOMMENDATION 3

THE DEPARTMENT MUST PHASE IN HIGHER LEVEL PROGRAMMING LANGUAGES FOR FUTURE DEVELOPMENT AND PHASE OUT THE PRACTICE OF WRITING PROGRAMS IN ASSEMBLE LANGUAGE.

RECOMMENDATION 4

STATE COMPUTER CENTERS NEED TO DEVELOP A FORMAL RECOVERY ("DISASTER") PLAN IN THE EVENT OF A DISRUPTION OF SERVICE FOR ANY SIGNIFICANT PERIOD OF TIME.

RECOMMENDATION 5

REVENUE"S COMPUTER CENTER AND THE GENERAL GOVERNMENT COMPUTER CENTER SHOULD BE WORKING TOGETHER TO MOVE IN THE DIRECTION OF PROVIDING BACKUP CAPABILITY FOR EACH OTHER FOR CRITICAL APPLICATIONS.

RECOMMENDATION 6

THE ON-LINE DRIVERS LICENSE PROGRAM SHOULD BE CHANGED TO A MULTI-THREAD PROGRAM WHERE MORE THAN ONE TRANSACTION AT A TIME COULD BE PROCESSED.

RECOMMENDATION 7

PROGRAMS SHOULD BE DESIGNED AND WRITTEN TO BEST CONFORM TO THE MODE OF OPERATIONS

RECOMMENDATION 8

THE DEPARTMENT SHOULD PHASE OUT THE PRACTICE OF PACKING DATA ON DISK FILES. IN ADDITION, FILES SHOULD BE ORGANIZED FOR HIGHER LEVEL LANGUAGE USE IN ORDER TO IMPROVE TERMINAL RESPONSE TIME.

RECOMMENDATION 9

CBI SHOULD CHANGE ITS PRIMITIVE MODE OF PROCESSING INQUIRIES TO THE DEPARTMENT OF REVENUE COMPUTER WHEN THE COMPUTER IS NOT AVAILABLE FOR PROCESSING.

RECOMMENDATION 10

THE DEPARTMENT SHOULD SEEK OUT NEW METHODS FOR DATA ENTRY AND PHASE OUT THE USE OF VIDEO 370 IN THEIR DATA ENTRY ACTIVITY.

RECOMMENDATION 11

DELAY THE IMMEDIATE IMPLEMENTATION OF THE FINANCIAL COMPUTER CENTER AND BEGIN TO PLAN AND DEFINE THE FINANCIAL MANAGEMENT SYSTEMS.

RECOMMENDATION 12

THE DEPARTMENT OF REVENUE, WITH THE ASSISTANCE OF THE DIVISION OF ADP, SHOULD DEVELOP A DETAILED IMPLEMENTATION PLAN FOR THE DEPARTMENT OF REVENUE TO MIGRATE TO A LARGE SCALE COMPUTER AND A FULL OPERATING SYSTEM.

During the implementation of the plan, written weekly status reports need to be produced to inform management of the progress or lack thereof of the project.

DEPARTMENT OF REVENUE
DATA PROCESSING
TASK FORCE
STUDY

INTRODUCTION

In April, 1977, Governor Richard D. Lamm approved the first annual Automated Data Processing (ADP) Master Plan prepared by the Department of Administration, Division of Automated Data Processing, with cooperation of many departments and agencies.

The 1977 ADP Master Plan emphasized the concept of a "Managed growth approach" to satisfy data processing requirements and needs for State Government. The plan recommended that data processing operation could result in the following computer centers or functional categories.

- Administration of Justice
- Financial Management
- General Government
- Higher Education Academic

The existing computer centers would be retained as separate operational units. These centers are:

- Labor and Employment
- Colorado University
- Colorado State University
- Colorado University Medical Center

The Division of ADP began to implement the first approved ADP Master Plan by creating Task Forces to study the various functional groups with their multiple alternatives to determine the most efficient and effective method of operations.

As of today, three Task Forces have been created to study the data processing workload requirements and capacity for:

1) General and Financial Management (ADP Master Plan, Volume II, January, 1978)
2) Administration of Justice (ADP Master Plan, Volume IV, January, 1979)
3) Computing in Higher Education (ADP Master Plan, Volume III, January, 1979)

Two of these task force studies, (1 and 2) have a direct relationship to this study.

GENERAL FINANCIAL MANAGEMENT STUDY

The General and Financial Management Task Force Study predicted a serious short fall in computing resources for the Department of Administration, Department of Social Services and Department of Revenue and their computer users. The task force recommended that two computer centers replace the existing three computer centers of Department of Social Services, Department of Revenue and the Division of ADP.

As a result of this study and its recommendations, funds were requested in Fiscal Year 1978-79 to begin the implementation of the two facility concept. Funds were appropriated to establish the General Government Computer Center, however, due to other higher budget priorities, funds were not made available to implement the Financial Management Computer Center.

The first year implementation and appropriation accomplished the following major objectives:

1) The consolidation of the Department of Social Services and the Division of ADP into a new computer center referred to as the General Government Computer Center (GGCC).

2) The two major functions of the Division of ADP were separated into two different organizations. The functions of managing a computer center being called the General Government Computer Center (GGCC) and the Statewide data processing function being called the Division of Automated Data Processing (ADP).

   The July 1978 creation of the General Government Computer Center resulted in a cost avoidance of 500,000 dollars for a larger computer and an actual reduction of twelve (12) FTE at an annual savings of 120,000 dollars in Fiscal Year 1979-80 funding.

INTERIM SOLUTION TO DEPARTMENT OF REVENUE'S SHORT FALL IN COMPUTING RESOURCES

In addition to the cost savings, the creation of the General Government Computer Center freed up State owned computer resources which could provide the Department of Revenue an interim solution to their short fall in computing resources. In December 1978, the following State owned computer resources were installed:

1) Department of Revenue's IBM 370/135 computer with .5 megabytes of main memory was replaced with a State owned IBM 370/145 with 1.0 megabytes of main memory having twice the relative computing power.

2) State owned computer memory was added to the existing Department of Revenue's IBM 370/145 computer providing increased performance capability.

3) Disk storage devices transferred to the Department of Revenue to support increases in growth in the drivers/vehicles files and further the development of on-line income and major tax systems.

The Department of Revenue's serious short fall in computing power was temporarily solved with the upgrade of State-owned computer resources. Computer batch jobs could now be completed on schedule and responses to operators communications for data via telephone facilities was being restored back to an acceptable level. The upgrade in computer resources, theoretically provides the Department of Revenue with an increase of 25% in relative computer power and provides an additional 1629 more available annual computer processing hours. The upgraded computer systems (dual IBM 370/145's) could provide up to 6520 available "problem state" processing hours per year. (See Appendix, Exhibit A).

The General Financial Management Task Force Study (ADP Master Plan, Volume II, January 1978) projected the following estimated total number of central processing unit (CPU) hours that would be required by the Department of Revenue's computer center for each of the fiscal years shown.

Application Workload Requirements
by Fiscal Year
(Based on a standard IBM System 370/145 CPU Hour)
CHART 2-1

Organization	78-79 CPU Hours	79-80 CPU Hours	80-81 CPU Hours	81-82 CPU Hours	82-83 CPU Hours
Department of Revenue	6,150	6,624	7,105	7,650	8,111

Revenue's upgraded computer system (dual IBM 370/145's) has a projected upper limit of 6520 central processing unit hours available per year.

It was predicted that the added computer resources would provide the Department of Revenue the needed computer capacity to meet their application workload requirements and the means to maintain a level of service acceptable to the end user into Fiscal Year 1979-80.

ADMINISTRATION OF JUSTICE STUDY

During Fiscal Year 1978-79 budget cycle, the State Legislature was prepared to transfer the operation of the Judicial Department's computer center to the General Government Computer Center, effective January 1979. The lack of knowledge regarding the Judicial Department's application workload requirements and level of service to be provided to the users postponed the decision to transfer the computer center operations pending the results of the task force study that was conducted with and about the Administration of Justice Agencies; namely Judicial Department, Departments of Correction, Institutions, Local Affairs, Law and the Colorado Bureau of Investigation.

In July 1979, the responsibility and funding for the operation of the Judicial Computer Center was transferred to the General Government Computer Center with the actual physical equipment move taking place in November 1979. The transfer of the operations of the Judicial Department Computer Center represents a major activity and its implementation requires patience and skill in addition to adequate funding.

In arriving at the data processing budget recommendations for fiscal year 1979-80, the Division of Automated Data Processing (ADP) was very cognizant of the fact that the Judicial Department Computer operation transfer represented a high risk activity and adequate appropriation would be essential for the successful implementation of the project. The Division of ADP recommended that the Judicial Department Computer operation transfer receive very high priority in the budget process; at the cost of delaying the budget request for the implementation of the Financial Management Computer Center (Department of Revenue).

RE-ASSESS DEPARTMENT OF REVENUE'S COMPUTER WORKLOAD REQUIREMENTS

Managements concern about fiscal reality has brought about the need to determine the present impact of the interim computer upgrade on the Department of Revenue's application workload requirements and to determine if a real need exists for the creation of a Financial Computer Center before requesting funds for Fiscal Year 1980-81.

A task force composed of staff members from Department of Revenue and Division of ADP were assigned to determine the data processing application workload requirements for the next five years and make recommendations to fulfill these needs.

PURPOSE AND SCOPE

The study was planned and organized to accomplish the following objectives:

1) Determine the Department of Revenue's ADP application workload requirements and computer hardware capabilities for the next five years.

2) Determine the feasibility of providing computer backup for administrative processing.

3) Determine the need and desire for a Financial Management Computer Center.

4) Produce a written report of the findings, conclusions, and recommendations.

ASSUMPTIONS

In looking at the limitations, and potential results of this study effort, certain conditions or parameters were applied in performing the required analysis, the following assumptions were used:

- The Fiscal Year 1979-80 budget should provide a base for analysis.
- Processing capability recommended must satisfy workload requirements for a minimum of three years.
- Present vendor hardware and software will provide sufficient base for projecting workload requirements.
- Sufficient hardware capacity will be provided to handle a 10% non-anticipated workload and to compensate for any potential errors in workload projections.
- The hardware and software monitors should provide sufficient information on current systems performance, utilization and capacity.
- The task force study team would acquire some sense of ADP operations and management procedures and should be free to comment and make recommendations as appropriate.
- ADP applications currently being run on the Department of Revenue's computers merit the type of processing being provided.

METHODOLOGY AND PROCEDURES

The task force used various methods to obtain the information needed. Management and end-users were interviewed to determine anticipated informational requirements and to obtain the quality of computer service being provided. Hardware and software monitors were installed to measure terminal response time and to measure computer performance and capacity. Computer operational reports and other publications were used to obtain current application workload, and to provide future workload indicators and trends.

The information collected was analyzed and measured against various established standards for indicating:

1) The level of computer service being provided for both batch and on-line processing;

2) The performance capability of the Central Processing Unit (CPU) and associated devices; and

3) The relative power capability of computers, expressed in the annual CPU hours available for processing for each size of computer configuration.

In addition, the Task Force examined operational procedures and practices as they pertained to computer performance, utilization and capacity.

The primary goal of the Task Force was to select alternatives and make recommendations that would provide the capability to increase employee productivity and performance, and provide a more efficient and economical means of operations. In addition, the recommendations should not distract from the Department's ability to continue to provide service to the end user or hinder the development of new ADP applications, i.e., accounts receivable, cash management.

DEPARTMENT OF REVENUE
DATA PROCESSING
TASK FORCE
STUDY

INTRODUCTIONS

This chapter presents pertinent information collected during this study such as, workload, growth projections, level of service being provided to the computer user, hardware capacity analysis, technical concepts, problem identification and possible solutions.

ORGANIZATION

The Department of Revenue's Administration/Data Processing Division organization structure and its relative position within the Department of Revenue is depicted on Exhibit B, in the Appendix.

In review of the organization chart for the Administration and Data Processing Division (left side of chart), it should be noted that the Director of Data Processing is responsible for two sections. These sections are: The Administrative Processing Section consisting of 199 positions and Data Processing Section consisting of 228 positions.

These two large sections operate as a unit in the Department of Revenue's day to day operation. The Administrative Processing Section is one of the most important factors in the Department's success in receipt, control and deposit of funds along with the dissemination of data to the various other Division and Sections.

The volume of work handled by the Administrative Processing Section can visibly be demonstrated by viewing the detail Data Processing organization in Exhibit B, in the Appendix. The Keypunch Section (center of the chart) consists of 143 data entry operators and is by far the largest data entry operation in the State.

It appears the main purpose for these two large, vital sections being together under one Division Director is to control and expedite the flow of data through-out the Department. However, the development of new processing equipment and data communication facilities has lessened the dependence of one section on another. In addition, the task force found the Department of Revenue to be the only State computer center where the Director of Data Processing was in charge of an additional large Division or Section within a Department.

HARDWARE CONFIGURATION

In 1955, an EAM card punch installation was set up for the purpose of processing income, sales, and withholding taxes plus motor vehicle registrations. This workload grew to the point where in 1960 a Booz Allen survey recommended the installation of computers in the department.

In 1961, two computers, an IBM 1401 and IBM 7070 were installed for the purpose of processing income tax, major taxes, vehicle registration and accident records. During this time, the State experienced growth to the point where these two computers were unable to cope with the volume. In 1965, they were replaced with a more powerful IBM 360/40 which continued to process the same workloads along with the conversion of the driver files and the expansion of the tax statistics and administrative processes.

In 1967, an IBM 1440 ATS System was installed to be used as data entry. The growth of existing applications and development of new applications made it necessary to upgrade the data entry computer to an IBM 360/30 in 1968. Again, the increase workload and the development of new applications caused the Department to upgrade the two 360 computers to dual IBM 370/145 and 370/135 computer configuration in 1972.

The two computer installation concept has prevailed since the start of the computer installation in 1961. Initially, the Department scheduled processor bound jobs on one computer system and input/output (I/O) jobs on the other computer system. Today, the two computer philosophy continues to be employed with the development of on-line telecommunication application, with one computer designated as the on-line communications computer and the other as the batch computer.

The Department's present two computer systems are loosely, coupled together where I/O devices can be shared between the two computers under a controlled environment. This concept reduces the processing capability of the two computers from 2.0 if not coupled, to a relative computer power range of between 1.7 to 1.9 because there are times when one CPU must wait for the other to release control of a file before the second CPU can use or access the same file. The Department's present computer configuration and data communication network are depicted in Exhibit C in the Appendix.

During this study, the task force had the Department of Administration, Division of Automated Data Processing (ADP) connect their hardware monitor to the computer systems, along with IBM software monitor to measure computer systems performance and capacity. The details of the hardware and software monitor will be discussed later in the report. However, one significant finding as it pertains to the use of two loosely, coupled computers, is the high disk contention between the two computers resulting in degrading terminal response times and a much lower relative computer power than was projected or anticipated.

ADP APPLICATIONS

Data Processings function in the Department of Revenue is an integral part of its operation and information control. Data Processing is employed in every major departmental program with heavy use in taxation, drivers licenses, distraint warrants, motor vehicle registrations and internal administrative programs. In addition, Department of Revenue's data processing provides access to Driver/Vehicle information for law enforcement agencies via telephone line connected between the Department of Revenue's computer and Colorado Bureau of Investigations (CBI) computer. The Department of Highway and State Patrol are users of accident reporting information which is entered into the computer for statistical analysis and reporting. Exhibit D, in the Appendix, describes the current ADP applications and the department's plans for modification and enhancement for those ADP applications.

PROGRAMMING LANGUAGES UTILIZED

The majority of the current applications are programmed in Basic Assembler Language (BAL). The following chart depicts the number of programs and the type of programming language employed in the current ADP applications.

CHART 3
PROGRAMMING LANGUAGES
Utilized by
DEPARTMENT OF REVENUE

PROGRAMMING LANGUAGE	NUMBER OF PROGRAMS
Basic Assembler Language	552
COBOL	203
RPG	-0-
Sort Programs	124
Utility Programs	9
Merge Programs	19
* Total Number of Programs and Options	907

*The total number of computer programs and options includes 79 on-line programs.

Revenue's uses of Basic Assembly Language as the main programming method can be contributed to several different factors which have been present from the start of the Revenue Computer Center. In the later fifties and through the sixties assembler language far exceeded higher level languages in performance and reduced computer time. In addition, hardware cost for computer memory and storage devices were high which made the facilities using assembler language more efficient and effective. The ability to pack data on storage devices and write programs with fewer instructions and tighter coding resulted in lower hardware utilization and cost.

In the seventies, high level languages have become more efficient. The trend in the industry has been to pay less for computer hardware while personnel and program development cost is continually growing at an accelerated pace. The effort required to convert assembler languages to a higher level language, instead of conversion, would enable the Department to direct their efforts in new development of applications and changes of existing applications.

Two factors, present today, which weighs very heavy in favor of using high level languages in programming most ADP applications is the extreme difficulty that the State is having in hiring computer programmers and the cost associated in training the new employees. One method of controlling cost of application development is to program in higher level languages. Higher level languages are being taught in Business Schools and Institutions of Higher Education. Secondly, the capability of higher level languages to be upward compatible with a vendor product line and the transferability of applications between computer processing center is highly desirable because of the ability to provide backup capability among similar computer facilities.

Current Level of Service

The Department of Administration, Division of ADP in their 1977 ADP Master Plan established service level standards for computer center to provide: performance measurements and guidelines for developing cost/benefits analysis for new applications; in determining impact on existing resources; and/or determining new hardware requirements. See Exhibit E in Appendix. These service level standards apply to both on-line and batch processing modes.

The two processing modes have different measures of efficiency, with the batch processing being throughput capability and the measure of efficiency of an on-line system is its response time. In a batch environment, the turnaround time between the submission of input from user departments and the availability of output is generally measured in hours or days. In an on-line environment, the turnaround time is called response time and is generally measured as the time from transmission of the last character of input from a terminal to the receipt of the first character of output from the computer. This response time is usually measured in seconds.

The following table depicts the service level standards for each type of service provided and Revenue's current performance measurement in meeting these standards.

DEPARTMENT OF REVENUES'
COMPUTER OPERATIONS
SERVICE LEVEL STANDARDS
PERFORMANCE MEASUREMENT

REQUIREMENTS	STANDARD	CURRENT % OF ATTAINMENT
Prime Shift - 8:00 AM to 5:00 PM		
On-Line (interactive) applications where full time operators are employed whose high productivity would be lost by poor response time.	Less than 5 seconds 99% of the time.	62%
On-Line inquiry applications where citizens information is being retrieved for agency and/or citizen inquiry and interactive program development.	Less than 10 seconds 95% of the time.	77%
Computer to Computer communication for operational information. (CBI inquiry into Revenue's Services and Vehicle records.)	Less than 10 seconds 99% of the time.	82%
Remote and local batch production jobs that require prime shift processing.	Less than 1 hour 75% of the time.	70%
	Less than 2 hours 100% of the time.	90%
Remote and local batch program compiles and test:		
o Less than 1 hour	75%	90%
o 1 to 2 hours	95%	95%
o 2 to 4 hours	98%	97%
o 4 to 6 hours	99%	98%
o 6 to 14 hours	100%	99%
Remote and local batch production jobs	Overnight (up to 14 hours) 99%	90%

The above current % of attainment figures were compiled from Supervisors of data entry weekly operational reports and from computer accumulated and generated reports on terminal response time.

Service being provided for batch jobs appears to be adequate with the majority of the batch jobs being turned around within their expected schedule. The processing of on-line transactions is less than desirable in third functional areas, i.e., data entry, CBI inquiries into Revenue's Driver and Vehicle records, and Driver's License Offices inquiries into driver's files. Prime shift hours from 9:00 AM to 11:30 AM and from 2:00 PM to 4:00 PM representing the worst periods of time with terminal response times of 30 seconds to 90 seconds not being un-common. Poor terminal response time has different affects on the end user depending upon the type of service being provided. In a Driver's License Office, the following chart depicts the number of applicants that could be processed based upon the terminal response time obtained.

DRIVER'S LICENSE OFFICE
APPLICANTS PROCESSED
BASED UPON TERMINAL RESPONSE TIME OBTAINED

	TERMINAL RESPONSE TIME	APPLICANTS PROCESSED PER HOUR
o	Less than 10 seconds (standard)	360 applicants
o	Less than 30 seconds	120 applicants
o	Less than 60 seconds	60 applicants
o	Less than 90 seconds	30 applicants

The above chart does not reflect the time required to process the application by an examiner. This time would be constant regardless of the response time obtained.

Based on the service level standard of 10 seconds response time, the examiners would be capable of processing 360 applications per hour. If terminal response time was degraded to 30 seconds for a period of one hour, the same examiners would process only 120 applications or a decrease of 66% from standard. Terminal response time has a direct affect on the Department's ability to provide a service to the public.

Poor terminal response time for the 143 Department's data entry terminal operations can best.be depicted in the cost of production measure in the number of documents or transactions entered by an operator per hour based upon the terminal response time obtained.

DATA ENTRY OPERATOR PRODUCTION BASED ON TERMINAL RESPONSE TIME OBTAINED

	RESPONSE TIME OBTAINED	RESPONSE TIME & TIME REQUIRED TO ENTER TRANSACTION	NUMBER OF TRANSACTIONS PROCESSED
o	Less than 5 seconds (standard)	35 sec.	103
o	Less than 10 seconds	40 sec.	90
o	Less than 15 seconds	45 sec.	80
o	Less than 20 seconds	50 sec.	72
o	Less than 30 seconds	60 sec.	60
o	Less than 45 seconds	75 sec.	48
o	Less than 60 seconds	90 sec.	40
o	Less than 90 seconds	120 sec.	30

Based on the service level standard of 5 second response time, Revenue's 143 terminal operators should have the capability of processing 14,729 documents per hour.

If terminal response time was degraded to 30 seconds response time for a period of one hour, the same operators would process only 8,580 documents. The degraded terminal response would result in 6,149 documents not being processed resulting in the cost of 60 operator hours lost due to poor response time.

Terminal response time in the case of CBI and the law enforcement community could result in timely response to a critical situation. Regardless of the type of service being provided, it should be apparent that computer operations should strive to obtain the service level standards established.

The improvement of terminal response time has no easy solution. The causes are numerous and complex. The task force used the Division of ADP's hardware monitor along with IBM's software monitor to assist in narrowing down some of the terminal response time problem areas. The task force's hardware and software findings will be discussed in greater detail later in this report.

The task force established a controlled test environment where various applications and situations could be measured by the hardware and software monitors and their results recorded. The following list identifies possible areas where action can be taken to improve response time.

- The present system configuration of two computers (loosely coupled) sharing direct access devices contributes to degrading the terminal response time. The batch computer presently locks out the on-line computer from gaining access to the on-line disk file on an average of 33% of the time. This contention reached as high as 90% during the testing period. Terminal response time was increased a magnitude of 2 to 8 times as a result of the systems lock out of direct access devices.

- Colorado Bureau of Investigation (CBI) and the law enforcement community presently have access to the Department of Revenue's drivers/vehicle information via tele-communication facilities provided by a computer to computer interface. The speed of the line which interfaces the two computers is a low speed line and should be upgraded to high speed to improve the response time.

  One change which could be a big improvement for CBI's and Revenue's response time as well as reduce processing time would be the discontinuation of CBI's practice to continue to que (store on disk) inquiries for Revenue's computer even after Revenue's computer is no longer available for processing. It appears a majority of these backlog requests would no longer be needed and creates unnecessary processing for both computers. For example, a patrolman stops a motorist and requests vehicle information from the Revenue computer via CBI computer. If the information is not received within a maximum of a couple of minutes, it is no longer needed. It should be apparent, if Revenue's computer is not available for a very long period of time, this CBI backlog of transaction can cause unnecessary processing for both computers. A more practical management approach would be to establish a short period of time (5 to 10 minutes maximum) to que the transaction when Revenue computer is not available and then only store a transaction which would still be valid and needed after Revenue's computer becomes available. In addition, transactions should be processed in priority sequence with the more critical or urgent inquiries having the highest priority and ready access to the computer.

- On line communication computer systems through-put can be improved by multi-tasking and by processing transactions in a multi-threading environment. Multi-threading is the ability to process more than one transaction at a time. The present drivers license on-line inquiry computer program processes transactions in a single-thread mode resulting in degrading the response time for all on-line users and increasing CPU utilization.

- The practice of packing data and stripping characters in the on-line disk files has added to terminal response time. Additional time is required to unpack and reassemble the record on each inquiry. In addition, the use of batch program modules for both batch and on-line file management may cause the inquiries to go through unnecessary routines to obtain the requested information.

- Revenue's present concept of using the computer for the data entry function (known as video 370) originated twelve (12) years ago with the installation of an Automated Terminal System (ATS) with 32 terminals. This concept may have been valid twelve years ago. However, the improvement of Key-to-Disk Systems within the last five to six years has provided management the opportunity to off load this data entry function. The off load of this function to Key-to-Disk System or other means of data entry could free up resources within the computer, thus, resulting in better response time for other uses. The use of the Key-to-Disk System should improve data entry production by improving response time, more system availability, and by increasing the operators average keystroke per hour.

The Department's terminal response time needs to be improved to an acceptable level with more consistent times for a long duration. Corrective steps need to be taken now to ensure the success of the Department's plans to move in the direction of more on-line systems and to further the development of new applications, such as cash management and accounts receivables.

TRANSACTION STATISTICS

The growth rate and workload indicators for Revenue's data processing can best be reflected in the number of documents processed and number of on-line terminal inquiries processed. The charts on the following pages depict the number of documents to be processed for each of the fiscal years shown.

DOCUMENTS PROCESSED BY FISCAL YEAR

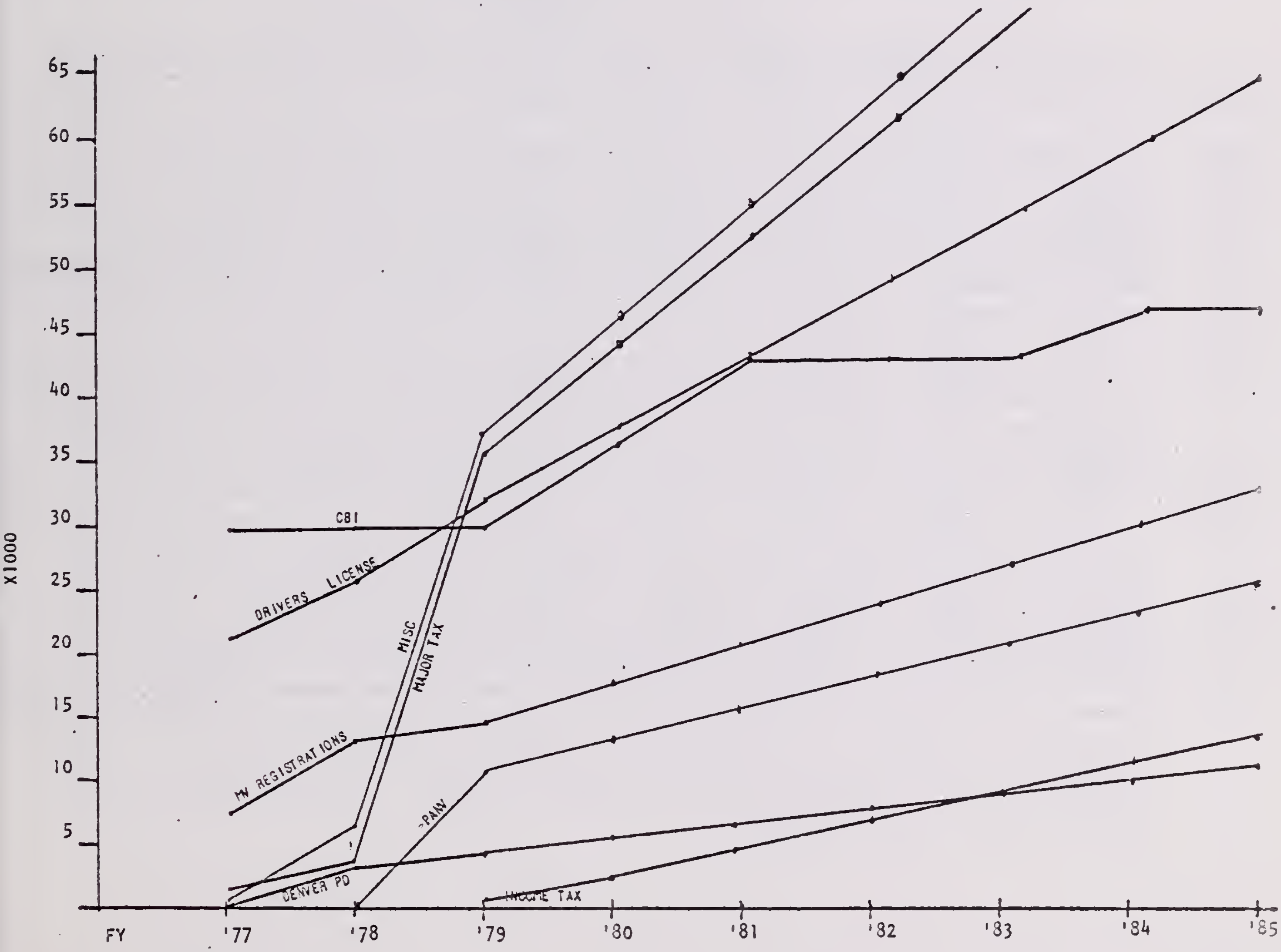
DOCUMENTS PROCESSED	FY76-77 Actual	FY77-78 Actual	FY78-79 Actual	FY79-80 Estimate	FY80-81 Estimate	FY81-82 Estimate	FY82-83 Estimate	FY83-84 Estimate	FY84-85 Estimate
All tax liabilities	3,811,716	3,967,875	4,085,110	4,248,514	4,418,454	4,595,190	4,779,000	4,970,000	5,169,000
Tickets	577,589	572,136	583,900	624,773	668,507	715,300	765,000	819,000	876,000
Drivers Lic. Issue	778,622	816,141	878,231	924,300	972,900	1,023,500	1,076,700	1,133,000	1,192,000
M.V. Registrations	2,440,207	2,593,046	2,689,982	2,824,481	2,965,705	3,113,900	3,269,600	3,433,000	3,605,000
Distraint Warrants	71,532	79,100	91,358	100,493	110,542	121,600	133,800	147,200	162,000
Sales Tax License	85,758	87,148	89,106	93,000	97,000	101,200	105,500	110,000	114,000
Deficiency Notices	38,939	40,426	85,842	93,000	103,500	113,800	125,200	137,700	152,000
Delinquency Notices	90,150	95,361	125,866	110,000	125,000	137,500	151,000	166,000	182,000
Active Liquor Acct	8,898	9,230	10,120	10,500	11,100	11,730	12,400	13,100	13,800
Accident	135,369	141,238	169,341	177,000	190,000	199,500	209,000	220,000	231,000

The following chart depicts the number of on-line terminal inquiries by fiscal year.

ON-LINE DATA COMMUNICATION

TERMINAL TRANSACTIONS

BY FISCAL YEAR



WORKLOAD PROJECTIONS

In studying past trends and growth projections, the task force noticed that most estimates on population, motor vehicles, driver licenses, etc. were usually lower than actual figures recorded. This philosophy appears to be sound in estimating revenue for future state expenditure plans, however, it is less desirable for projecting future computer resources to accomplish the workload requirements. The task force elected to use the conservative estimates for projecting future workload requirements with the thought that sufficient computer processing power should be made available to handle 10% non-anticipated workload requirement and to compensate for any conservative estimates

The Department of Revenue's data processing plan reflects an accelerated direction in processing mode for ADP applications with the ability to update the various master files on a daily basis rather than a weekly or monthly basis.

The philosophy of on-line processing, where cost justified, affords the Department the opportunity to process information in a more timely and accurate method. Errors are usually detected at the source where corrections can be made properly by those individuals most knowledgeable about the data, thus saving time and costs associated with improper correction. In addition, management information is up-to-date for making decisions for various Departmental programs resulting in more timely collections of revenue and better service.

The improved on-line mode of processing data does require more CPU time on the computer than the batch mode of processing. Additional CPU processing power is required for communicating with the terminals and executing various additional tasks. Such as logging transactions for backup purposes in case of system failure and for providing security procedures requires even more CPU time.

The impact of the current ADP application and future development of new applications on computer processing requirements are reflected on Chart 3-5 on the next page. The CPU hours for each application depicted on the following chart, were arrived at by reviewing and analyzing several different sources and documents, i.e., Department of Revenue's Annual Reports, Budget Reports, ADP Plans, and the ADP Management Reports. The ADP Management Reports are produced from data accumulated within the computer on each application being processed and included such information as the actual CPU hours utilized, number of transactions processed, and terminal response time. The chart represents the projected central processing hours required annually to run each ADP application through Fiscal Year 1984-85.

CHART 3-5

DEPARTMENT OF REVENUE
PROJECT
APPLICATION WORKLOAD REQUIREMENTS BY FISCAL YEAR
(BASED ON CURRENT CPU HOURS

ICATION NAME	79-80 CPU HOURS	80-81 CPU HOURS	81-82 CPU HOURS	82-83 CPU HOURS	83-84 CPU HOURS	84-85 CPU HOURS
or Tax	1170.4	1287.0	1416.0	1557.0	1713.0	1884.0
me Tax	908.0	945.0	982.0	1022.0	1063.0	1106.0
vers License	816.7	865.7	909.0	954.4	1002.1	1052.2
or Vehicle	635.0	667.0	700.0	735.0	772.0	811.0
traint Warrants	196.2	215.8	237.4	261.1	287.3	316.0
ident Reporting	183.6	194.5	206.2	218.6	231.7	245.6
eritance Tax	99.4	99.4	0	0	0	0
uor Tax	50.0	51.5	53.4	54.7	56.2	57.9
or Fuel Refund	10.0	12.0	14.8	16.0	18.0	20.0
rol Tickets	20.8	21.6	22.4	23.4	24.3	25.2
or Fuel Bills	176.0	185.0	194.0	204.0	214.0	225.0
enditure Vouchers	37.0	37.3	37.7	38.1	38.5	38.8
ncy Budget Ledger iance Reports	10.0	10.1	10.2	10.3	10.4	10.5
ration	24.8	26.5	27.8	29.2	30.6	32.1
duct Control	83.6	87.8	92.2	96.8	101.6	106.7
ernal Administration	204.9	211.1	221.6	232.6	237.3	242.0
line Telecommunications	1002.5	1203.0	1323.3	1455.6	1601.2	1761.3
tem Software	120.0	220.0	253.0	291.0	335.0	385.0
Applications ounts Receivable	0	100.0	102.0	106.0	110.0	114.0
h Management	0	50.0	51.0	52.0	53.0	54.0
eling System Support	0	20.0	21.0	22.0	23.0	24.0
omated Audit Techniques	0	25.0	26.3	27.6	29.0	30.4
-Anticipated Workload	574.0	653.0	690.0	740.0	795.0	854.0
AL ANNUAL PROCESSING RS REQUIRED	6322.9	7188.3	7591.3	8147.4	8746.2	9395.7

The annual CPU hour projections, shown in the previous chart, incorporate the total workload for both Revenue computers for three shifts per day based upon a seven day per week operation. These annual workload hours, if charted, would give a linear picture of Revenue's processing. When, in fact, Revenue's processing of their workload requirements reflects peaks and valleys as a normal operation.

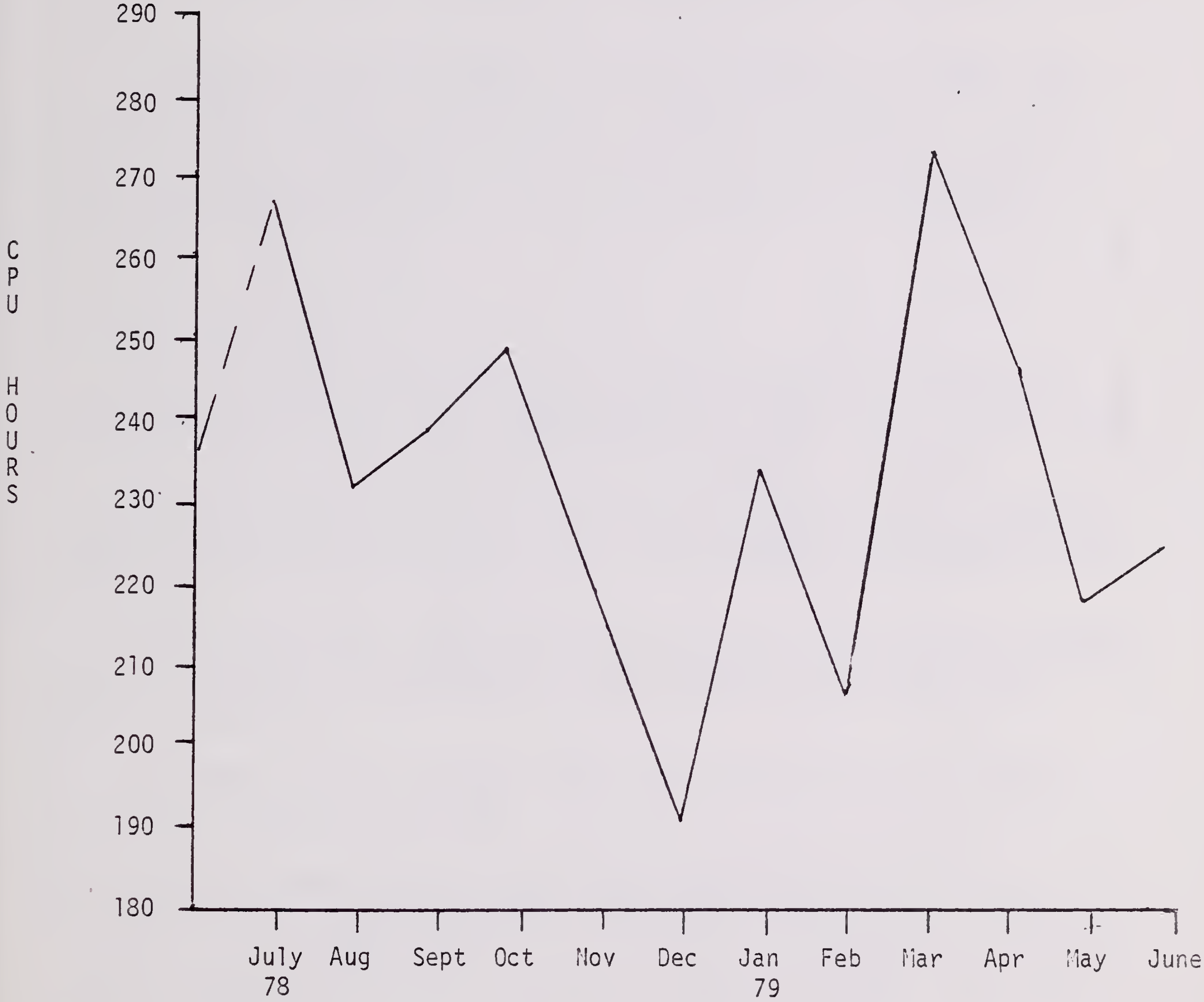
Revenue's highest workload impact for the on-line computer system occurs during the working hours from 8:00 AM to 5:00 PM (prime shift). Prime shift hours from 9:00 AM to 11:30 AM and from 2:00 PM to 4:00 PM represents the worst period of time with terminal response time of 30 to 90 seconds not being uncommon. Batch processing of the Department's workload is heavier during the second and third shifts of computer operations for the day.

The months of January, March and April are the highest periods of processing hours. The following chart on the next page reflects Revenue's actual processing hours required monthly for each computer to run the ADP applications for fiscal year 1978-79.

REVENUE'S BATCH COMPUTER

ACTUAL APPLICATION PROCESSING HOURS

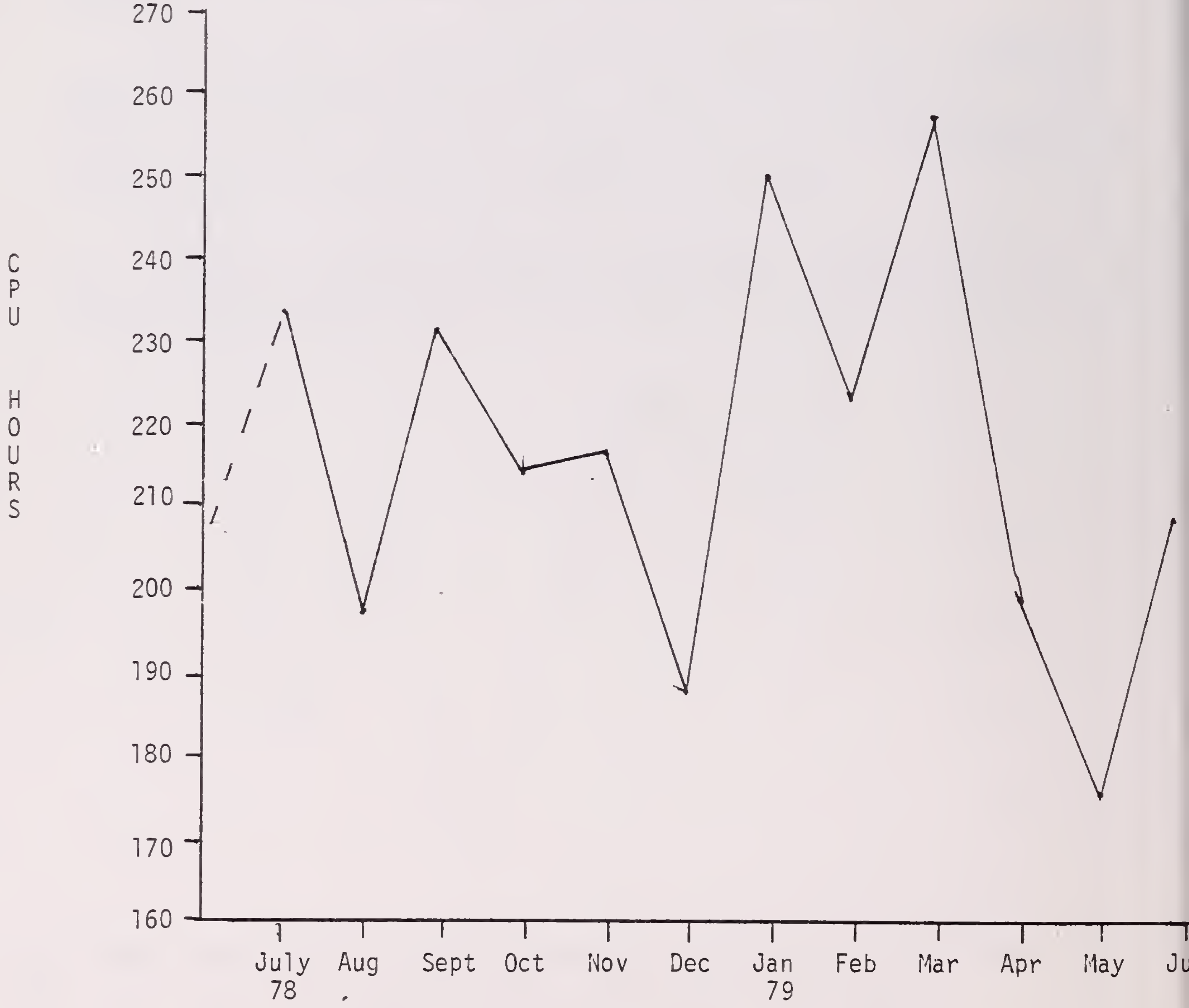
BY MONTH FOR FISCAL YEAR 1978-79



REVENUE'S ON-LINE COMPUTER

ACTUAL APPLICATION PROCESSING HOURS

BY MONTH FOR FISCAL YEAR 1978-79



The previous charts have two periods of time represented in them which must be understood in analyzing the charts for workload peaks and valleys. The months of July through November reflects the use of a smaller computer for the batch computer system and an on-line computer system with less resources than the remaining seven months. This would account for some of the monthly CPU hours being higher than normal, for example, the 268 CPU hours in July for the batch computer.

In December, the batch computer system was upgraded with a larger State owned computer and additional memory was installed on the on-line CPU, resulting in a decrease of monthly CPU hours between November and December. The chart on the on-line computer system gives a fairly accurate picture of Revenue's processing cycle. The monthly CPU processing hours help demonstrate Revenue's processing cycle which the task force needs to be aware of in determining processing requirements.

Relative Computer Power

One of the major ways of determining computer processing needs is to evaluate and compare the impact of existing and projected application workload requirements to the relative computer power of the current computer system configuration and various larger computer configurations.

Relative computer power is an approximation of the total performance and capability of a computer system relative to other computer systems. Relative power is established by the industry and can be obtained from various industry publications.

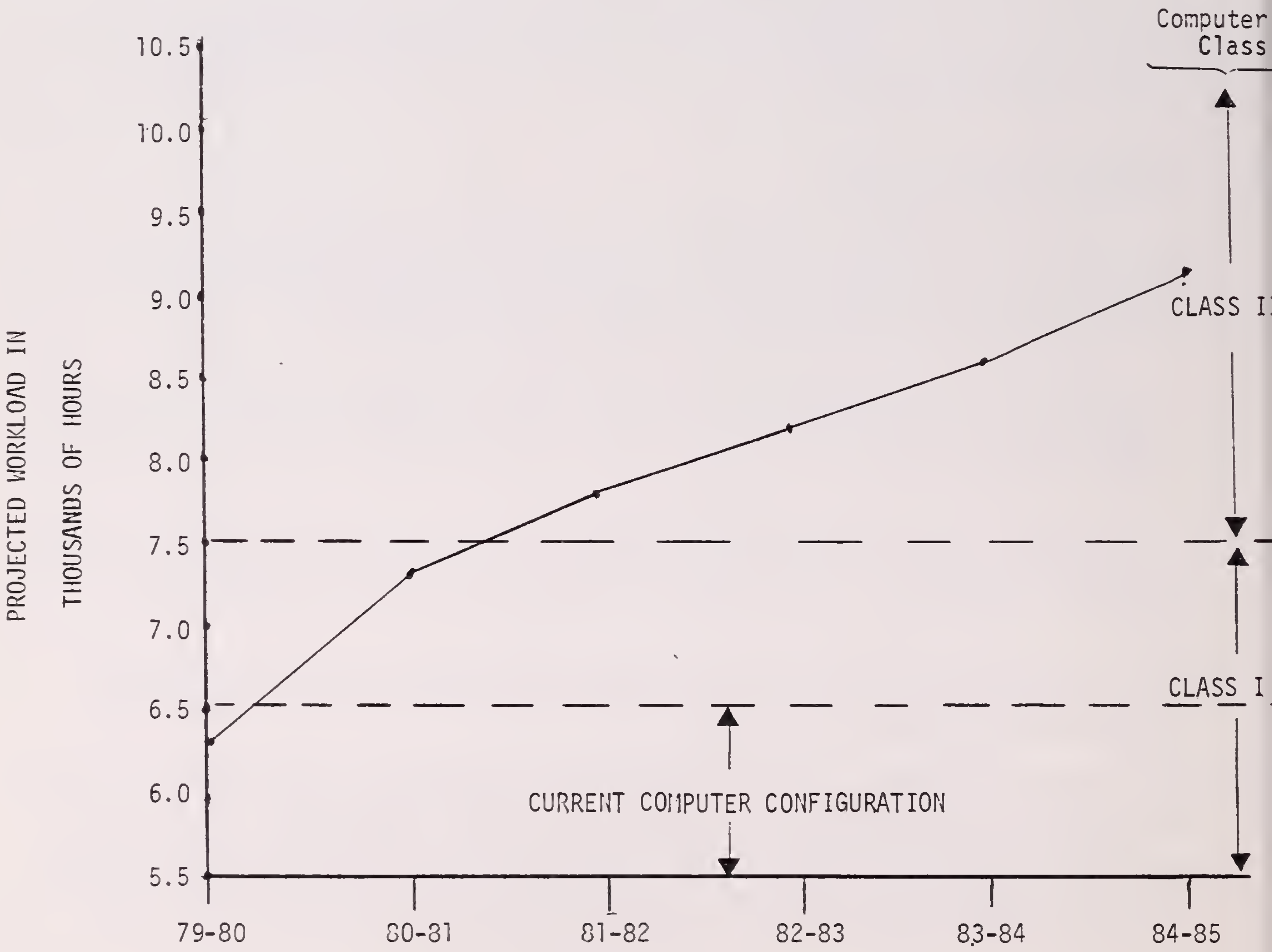
The task force used relative computer power as one of the tools available to determine the size of computer necessary to process the projected application workload. Exhibit A in the Appendix explains how relative computer power figures were obtained.

In summary, relative computer power is the capability of the computer expressed in total annual available hours for the computer to process the existing and projected workloads.

The existing and projected workloads are expressed in the number of central processing unit (CPU) hours required annually for the Department of Revenue through the planning period of fiscal year 1984-85. The task force estimated the future ADP application workload requirements using a standard CPU hour and computer program mix similar to the existing computer equipment, IBM System 370, Model 145, and application computer programs.

The following chart depicts the estimated total number of Central Processing Unit (CPU) hours that will be required by Revenue's Computer Center for each of the fiscal years and reflects the class of computer having the relative power to process the workload.

DEPARTMENT OF REVENUE'S
PROJECTED WORKLOAD
FOR FISCAL YEAR 1979-80 THRU 84-85
APPLIED TO RELATIVE COMPUTER POWER.



The horizontal lines on the previous chart represents the total, estimated central processing hours available for each computer configuration shown on the right of the chart. The total available CPU hours (11,592) for the top computer configuration (Class II) exceeds the planning period.

In Fiscal Year 80-81, the projected application workload requirements in CPU hours will exceed the Department of Revenue's current Class I computer configuration's (IBM 370/145-145 coupled) available processing hours. An upgrade to another Class I coupled computer configuration would provide only temporary relief thru Fiscal Year 1980-81, while an upgrade to a single Class II processor would provide sufficient relative computer power for the planning period.

Based upon the present environment, the Department of Revenue will experience a projected computer shortfall in Fiscal Year 1980-81. The task force needed to validate the performance, utilization, and capacity of the current computer system to validate the relative power and classification of central processing units. The current computer system served as the base for the task force projections of future workload requirements and establishment of total available annual processing hours in relative computer power computations.

Computer System Performance and Capacity

The determination of a computer systems performance and capacity is an extremely difficult task to measure and evaluate. External from the computer, the task force was able to measure and evaluate the level of computer services being provided to the users, i.e., terminal response time, the ability to turnaround jobs within the scheduled time, etc.

Fortunately, the task force was able to employ the Division of Automated Data Processing's hardware monitor and IBM's software monitor which provided the means to measure the existing computer configuration's performance and utilization.

The Division of ADP's Tesdata 1155-B Computer Hardware Monitor was attached to the Revenue dual IBM 370/145 computer system from 6:00 AM, April 13, 1979 through 9:00 AM, May 15, 1979. The Hardware Monitor samples the various Central Processing Unit (CPU) and channel activities in various AND/OR logical combinations every microsecond and writes a record on magnetic tape in increments of time varying from one microsecond to ten minutes. The ten minute increment was used on the Revenue computer system to facilitate the gathering of data to generate a Systems Profile for the given period of time. The Tesdata Host Data Reduction Software was used to generate the reports necessary to analyze the computer system. In addition, Condition Tested Mark IV Reports were used to further analyze the Revenue computer system. This report contains the major findings from the various reports produced by the hardware and software monitors. Conservation and sheer volume of the detail reports prohibits the inclusion of all these reports in this report. Persons who are interested in further clarification and detailed information may review these reports at the Division of ADP.

The purpose of a systems profile is to determine whether the CPU/Channel function are operating within acceptable limits and/or to ascertain if there are any apparent "Bottlenecks."

Definitions

Mean

The mean is the sum of the values for each case (hour) divided by the number of cases (hours).

Case

A case refers to an interval of time for which the CPU/Channel function data was summarized. (One hour for this analysis)

Practical Control Limits

Practical control limits are measurements established by the industry to define the upper limitations of performance capability for the Central Processing Unit and associated channels and peripheral devices to operate before service is degraded. The Practical Control Limits for measuring and evaluating are:

- CPU Busy = 85% ± 5%
- CPU Wait = 20% ± 5%
- Disc Channel = 35% ± 5%
- Tape Channel = 55% ± 5%

Findings

For all 771 cases (hours) for which CPU/Channel function data was summarized, the mean utilization percentage was: (Testdata Host DRS)

		System A Batch Computer	System B On-Line Computer
o	CPU Busy	59%	57%
o	CPU Problem	32%	*
o	CPU Supervisor	27%	*
o	CPU Wait	39%	42%
o	CPU Stop	2%	1%
o	Channel 0 Byte MPX	1%	2%
o	Channel 1 Disc/Tape	28%	10%
o	Channel 2 Tape	25%	17%

* Not available

The task force could not identify any unusual circumstances or bottlenecks in the review of the above percentage of utilization of the various components. However, the task force knew the above percentage of utilization is an average which includes all three shifts and Saturday and Sunday in the total cases (hours). These figures computed into the average totals for an on-line computer system tends to distort the utilization and does not explain why Revenue is experiencing poor terminal response time on Prime Shift (8:00 AM to 5:00 PM). The following chart depicts the mean utilization percentage for the testing period by shifts for both the batch and on-line computer systems.

		System A Batch Computer	System B On-Line Computer
CPU Busy			
o	1st Shift (0800-1600)	65%	72%
o	2nd Shift (1600-2400)	59%	47%
o	3rd Shift (2400-0800)	54%	49%
o	All Shifts (0000-2400)	59%	57%

	System A Batch Computer	System B On-Line Computer
Channel 1 Disc/Tape Busy		
o 1st Shift (0800-1600)	27%	10%
o 2nd Shift (1600-2400)	27%	9%
o 3rd Shift (2400-0800)	26%	9%
o All Shifts (0000-2400)	27%	9%
Channel 2 Tape Busy		
o 1st Shift (0800-1600)	25%	12%
o 2nd Shift (1600-2400)	21%	18%
o 3rd Shift (2400-0800)	28%	18%
o All Shifts (0000-2400)	25%	16%

The task force found no significant indication of any major bottlenecks in the overall system profile of the Batch Computer System A. However, the task force was concerned with the high CPU busy measurement of 72% on prime shift for the on-line computer System B. This concern is further solidified in the following chart which depicts the percentage of time during the test period that the on-line computer system exceeded the practical control limits:

CONDITION TESTED
FOR CPU BUSY
EXCEEDED PRACTICAL CONTROL LIMIT

- o The CPU Busy on Batch Computer System "A" is greater than 80%

37% of the time on - Prime Shift

29% of the time on - Second Shift

25% of the time on - Third Shift

- The CPU Busy on On-Line Computer System "B" is greater than 80%

    46% of the time on - Prime Shift

    11% of the time on - Second Shift

    17% of the time on - Third Shift

The task force felt that 46% of the time on prime shift the CPU was processing above the practical control limits, degraded the CPU capability to process, thus resulting in poor terminal response time. The task force still was not totally satisfied what was causing the on-line computer system to reach saturation in CPU resources. The high CPU utilization could be caused by a bottleneck or Revenue's workload had exceeded the capacity of the computer, thus causing the degradation in processing.

The task force elected to establish a control test environment where various situations and conditions could be tested and measured to arrive at a logical conclusion for the high CPU utilization and poor terminal response time on the on-line computer system. The conditions and situations consisted of testing the impact which various on-line applications had on the CPU utilization and terminal response. In addition, system configuration tests were conducted to measure the effects the batch and on-line computers had on each other in sharing input and output devices. The following list summarizes the major findings of the controlled test:

- The present system configuration of two computers (loosely, coupled) sharing direct access devices contributes to degrading the terminal response time. The batch computer presently locks out the on-line computer from gaining access to the on-line disk file on an average of 33% of the time.

    The contention reached as high as 90% during the testing period. Terminal response time was increased a magnitude of 2 to 8 times as a result of the systems lockout of direct access devices. This high systems lockout does not appear to be the cause of the high CPU utilization on the on-line computer system. However, this finding does affect the task force's project of relative computer power figures which were used to determine the size of computer necessary to process the Department's projected ADP application workload.

    The task force used a 90% efficiency level for arriving at total availability annual processing hours (relative computer power) for each computer configuration where two computers were loosely coupled through the sharing of input/output devices.

The efficiency level used in determining relative computer power to loosely, coupled computer configuration (two computers) should have been in the range of 60-80% and not 90%.

- On-line communication computer systems through-put can be improved by multi-tasking and by processing transactions in a multi-threading environment. Multi-threading is the ability to process more than one transaction at a time. The present driver's license on-line inquiry computer program processes transactions in a single-thread mode resulting in degrading the response for all on-line users and increasing CPU utilization.

- The on-line data entry function (known as VIDEO 370) contributes to the high CPU utilization. The off-load of this function to Key-to-Disk system or other means of data entry should free up resources within the computer, resulting in better response for other users and make better use of the computer.

The use of the hardware and software monitors enabled the task force to get a more accurate determination of the use of the present computer configuration and identify areas where improvements could be made. In addition, the monitors helped to validate previous findings on applications workload projections and relative computer power.

The task force was concerned with the performance level being obtained from the coupling of the batch and on-line computer systems. Two major objectives for coupling two computers system is the ability to segregate processing modes, i.e., batch and on-line; and the capability to provide backup processing for each other.

COMPUTER BACKUP

The Department's two computer concept has prevailed since the start of their computer installation in 1961. The concept has evolved into the present philosophy that the two computers could provide backup capability for each other. Computer centers in Colorado State Government have experienced a change in providing services to the end users. The parochial role where data processing personnel were responsible for capturing, manipulating, validating and disseminating information for the end user has evolved into bringing the computer to the end user via data communication terminals. This on-line mode of processing has created new technical problems for data processors to solve. The potential for prolonged periods of computer systems downtime (not available for processing) may impair the end users ability to meet deadlines, to provide adequate services to their general consituents, and create non-productivity hours among employees.

There are two main factors which should be considered in determining backup processing needs. It is necessary to be able to predict the likely length of time the computer will be down and the impact on the State.

The task force obtained Revenue's operational log of computer downtime for the period of January 1, 1978 to June 30, 1979 - a total of eighteen months. The computer systems were down for a total of 169 hours during the eighteen months. Exhibit F in the Appendix contains the causes of downtime. The following summarizes the downtime recorded into three major areas.

TOTAL SYSTEM
DOWNTIME DUE TO MALFUNCTION

AREA	HOURS	% OF TOTAL DOWNTIME
Central Processing Unit	76	45
Input/Output	41	24
*External	52	31
	169	100%

*Electrical power building, air conditioning, power failure (Public Service Co.)

The computer system was available for processing on a limited basis approximately 1/3 of the time the system was recorded down due to a malfunction. The Department recorded a 98.7% system availability during the eighteen months and 87% of the time the computer was down for less than one hour duration.

No time during this eighteen months did the computer operations employ the other computer for backup purposes. Most failures were of the nature that the other computer would not have been a help, i.e., power failure, air conditioning, disk, etc., and the remainder of the time was not worth while to change because of the short duration of downtime.

Based upon the above findings the conclusions could be that the Department of Revenue does not need computer backup capability. This is not true, the Department of Revenue, like other State computer centers, has a need for backup computer capability when prolonged downtime is experienced or if a disaster was to occur.

In analyzing Revenue's various ADP applications to determine the risk involved in not processing applications, the task force decided that the maximum time the computer could be down before the Department would reach a critical point would be 24 hours for the cash management program.

The State Auditor has published various audit reports; i.e., General Government Computer Center, Metropolitan State College, etc.; which recommend that a formal recovery plan should be prepared for the computer center and user personnel in the event of a disruption of service for any significant period of time.

The intent of the recommendation for the lack of a disaster plan is directed toward the ability of the various computer centers and users to recover data, programs, operations and controls so that State user agencies can carry on business without major disruption. Data processing must start moving in this direction.

The ability to recover protects against the widest set hazards, including many that cannot be anticipated or prevented. A backup computer installation should be far enough away from the primary facility so it is not subject to the same hazards, but it should be accessible and close enough to serve its users.

Physical separation ensures that both locations will not be crippled by a single fire, explosion, airplane crash, or any other single accident; and it reduces the risk of simultaneous damage from weather hazards. The benefits of physical separation can be further enhanced by:

- o obtaining electric service from separate substations so that a single power outage would not disable both locations, and

- o avoiding use of common communications trunk or exchanges in communications-oriented systems.

The State of Colorado having multiple computer installations have what may be the ideal backup situation, since two of the larger computer installations, i.e., General Government Computer Center and the Department of Revenue; are geographically close and have separate power supplies and different communications exchanges. The advantages of this kind of backup is that it is available immediately and it is under State control. It may be necessary in the case of Revenue to provide additional computer capacity to take on the extra workload in a backup situation with the General Government Computer Center.

Backup facilities should be similar in computer configuration and software so that the transferability of critical applications can take place within the required time frame.

OPERATING SYSTEMS:

The Department of Revenue Computer Center and the General Government Computer Center currently run under different computer operating systems. The Department of Revenue computers operate under the control of a Disk Operating System (DOS) and the General Government Computer Center operates under the control of a full Operating System (OS).

DOS operates more efficiently in small and intermediate computers, i.e., IBM 370/145-148 and 4300's with OS being more functional in large scale computers, i.e., IBM 370/158-168 and 3300's.

The full Operating Systems (OS) provides better programmer interfaces, improved resource management, improved security and reduced operator involvement. OS is also more responsive to change and results in better system throughput and improved productivity of people. The increase of productivity can mean more consistant service to the end user.

Revenue migration to a full Operating System would give the State the opportunity to:

- Provide computer backup capability between State computer facilities for critical applications. Such as the Central Accounting, Treasurer, Payroll and Personnel; Cash Management Taxation, Legislative Bill Drafting and Social assistance to name a few.
- Improve Revenue's computer operation by increasing the productivity of the employees and provide higher and more consistant service to the end users.
- Reduce the number of computer operations personnel needs to run the computer.

The following chart reflects the reduction in Revenue's computer operations personnel, if the computer configuration was to be upgraded to a single computer system. A further reduction of personnel would take place once OS was fully utilized as the computer operating system.

REVENUE'S COMPUTER
OPERATIONS PERSONNEL
COMPARISON
SINGLE COMPUTER VS. MULTIPLE COMPUTER AND OPERATIONS SYSTEM

CLASSIFICATION	Two Computer DOS	One Computer DOS	One Computer OS
Librarians	3	3	1
Computer Supervisor	3	3	3
Principal Computer Operator	4	4	4
Sr. Computer Operator	4	3	3
Computer Operator B	7	5	4
Computer Operator A	5	4	3
Operation Supervisor	1	1	1
Scheduler	1	1	1
TOTAL OPERATIONAL PERSONNEL NEEDED	28	24	20

The reduction of 8.0 FTE operational personnel could result in $95,000 savings in the first year. This savings would be realized once Revenue completed the migration to a full operating system. The department will need one Software Specialist to assist in bringing their computer operations to the State of the Art. The long range personnel savings will be much greater, if today, the State was to hire an employee at age 25 at a salary of $12,000 plus benefits with an annual salary increase of 5.6% and the individual was to retire at age 55 with 30 years of service with no promotions. The personal services cost to the State for this employee would be over a million dollars.

The three major problems facing this country today, as defined by the President's Business Advisory Committee, are productivity, inflation and energy. Based upon the current State's General Fund spending limitation of 7%, it would be apparent that one way of increasing productivity will be through the use of computers in a cost justification mode. The sharing of data processing facilities, personnel, and common applications will help to reduce the cost.

FINANCIAL COMPUTER CENTER

One of the primary objectives of this study was to determine if a real need or benefit exists for consolidating the financial applications into one computer facility. The Financial Computer concept was an outgrowth of the 1977 ADP Master Plan and was conceived by data processing. The concept consists of transferring the central activities of accounting, treasurer, personnel, payroll, purchasing, and budgeting to the Department of Revenue's Computer Center.

The task force interviewed management of the affected agencies and obtained the following major findings:

- The State Controller and the Department of Revenue is in need of accrual information for major tax and income tax. The State Controller is in need of summary information with Revenue needing the detail accounts receivables information. When the application is implemented, the present mode of operation will satisfy both department's requirements.
- The State should be moving in a more accelerated pace to establish a Colorado Management Information System (CMIS). The scope of CMIS should be far more reaching than the present financial systems data and should include economic, program, demographic, etc., type data for modeling, projections and planning. This type of system could conceivably cross over multiple computer facilities in satisfying informational requirements.
- The consensus of the majority of the affected agencies saw no real need to transfer the present systems to the Revenue's computer facility. The cost to transfer and the cost of time should be considered before any steps should be taken. In addition, the majority of the affected agencies felt that the additional cost could best be used to enhance and expand the current system and any new systems development.
- All the affected agencies see a need for a management information system which would be capable of interfacing all the centralized information together and give continuity of data among the various activities, i.e., accounting, payroll, personnel. In addition, the system should be flexible to change and expand with the capability of ease-of-use, so management can present various situations and alternatives to the system and receive the information back in a timely manner and in a prescribed format.

The Division of Accounts and Control, Department of Personnel and the Office of Planning and Budgeting are working together to interface the present central systems and to define future requirements and needs.

The information contained in the current central functions of accounting, payroll and personnel lack continuity due to deficiencies in systems interfaces. The Department of Personnel is presently designing and implementing the personnel system on a data base management system (DBMS). Once completed, the next step is to have the personnel system drive the payroll system. This appears to be the starting point for building a management information system.

The Division of ADP is presently developing a Statewide Data Communication Master Plan. One objective of this plan is to provide a data communication network where multiple computers can be assessed by an end user to satisfy their informational requirements. The goal is to provide this service with little awareness or involvement of the terminal operator as to the location of their data. The State presently utilizes this concept on a limited basis. Until the concept is more fully developed and implemented, the transfer of the central activities to the Revenue computer facilities would produce additional data communications and terminal costs. Most agency's terminals support multiple applications and these applications will still be served by the General Government Computer Center with their financial applications being supported by the proposed Financial Computer Center, thus adding an additional cost for terminal and communication facilities for the majority of the General Government Computer Center users.

CHAPTER IV CONCLUSIONS AND RECOMMENDATIONS

DEPARTMENT OF REVENUE
DATA PROCESSING
TASK FORCE
STUDY

INTRODUCTION

This chapter contains the conclusions and recommendations arrived at by the Task Force in determining:

(1) The Department of Revenue's ADP application workload requirements and computer hardware processing needs for the next five years, and

(2) The feasibility of providing computer backup capability for administration processing, and

(3) The need or desire for a Financial Computer Center.

The primary goal of the task force was to select alternatives and make recommendations that would provide the capability to increase employee productivity and performance, and provide a more efficient and economical means of operation. In addition, the selected alternatives and recommendations should not distract from the Department's ability to continue to provide service to the end user or hinder the development of new ADP applications, i.e., accounts receivable, cash management.

The following sections within this chapter are organized for readability and clarification purposes and does not reflect a priority of importance with reference to recommendations.

Organization

The State of Colorado has grown and developed at a fast pace over the last ten years. Likewise, the data processing industry has rapidly advanced in technology and capability. Managements ability to keep pace with these changes takes total commitment and dedication.

The Data Processing function in the Department of Revenue is in the Administrative and Data Processing Division. The function has full processing capability including systems development, programming operations, control and data entry.

OPERATIONAL CONSIDERATIONS

The three major problems facing this country today, are productivity, inflation and energy. This can further be exemplified by the State's enactment of the 7% spending limitation on the General Fund. Management will have the responsibility to seek out new methods and technologies as well as improve and change existing practices and procedures to be more efficient and economical.

Data Entry

The Department of Revenue has the largest data entry organization in the State with approximately 143 full time positions. Past trends in data entry have been to increase production through the establishment of new positions. This practice has led to a stop-gap approach to solving immediate problems. The long range approach should be to look at more efficient and economical ways of increasing productivity.

The Department presently employs approximately 70 full time employees for their on-line data entry activity, known as Video 370. This activity may have been a good practice twelve years ago when it was first installed. However, today, the data processing industry has made advancements in data entry equipment where more economical and efficient methods have been developed. The Department has installed key-to-disk data entry systems for some of their ADP applications. This method has proven to be more productive due to better terminal response time and better system availability.

The practice of using the computer for data entry function (Video 370) increases the computer utilization, thus contributing to degrading service being provided to other users of the computer. The Department should consider new methods and technology in their data entry activity. Alternatives which could be considered are: on-line terminal update, optical scanning, key-to-disk, point of entry banking terminals, etc.

RECOMMENDATION 1

THE DEPARTMENT SHOULD SEEK OUT NEW METHODS FOR DATA ENTRY AND PHASE OUT THE USE OF VIDEO 370 IN THEIR DATA ENTRY ACTIVITY.

The phase out of Video 370 should be accomplished with good fiscal management employed to minimize the economical impact to the Department. Data entry is a statewide problem facing many of the Departments and Institutions today.

SOFTWARE

The trend in the industry has been to pay less for computer hardware, while personnel and program development costs continue to grow at an accelerated pace.

Data processing languages have evolved from low level languages (assemblier) in the fifties and sixties to higher level languages, (COBOL, FORTRAN) in the seventies. This evolution is continuing to yet higher level languages to meet the increasing demands of end-users for shorter development time and for more timely information. The perfection of these higher level languages in the eighties should help control the growing personnel and program development costs.

The majority of the Department of Revenue's computer programs are written in low level assembler language. The continued use of this low level language will impede their progress to provide service to the end user.

RECOMMENDATION 2

THE DEPARTMENT MUST PHASE IN HIGHER LEVEL PROGRAMMING LANGUAGES FOR FUTURE DEVELOPMENT AND PHASE OUT THE PRACTICE OF WRITING PROGRAMS IN ASSEMBLER LANGUAGE.

The phasing out of the assembler language programs will have to be accomplished over a longer period of time than is desirable. The cost to convert programs and files will be too costly and too time consuming for the Department to absorb. Through the use of assembler language the programmer had the ability to pack data and strip characters from records for conserving space on disk storage devices. This practice has added to the poor terminal response time and made it more difficult to convert and use higher level languages.

RECOMMENDATION 3

THE DEPARTMENT SHOULD PHASE OUT THE PRACTICE OF PACKING DATA ON DISK FILES. IN ADDITION, FILES SHOULD BE ORGANIZED FOR HIGHER LEVEL LANGUAGE USE IN ORDER TO IMPROVE TERMINAL RESPONSE TIME.

Terminal response time could be improved by discontinuation of three programming practices. The practice of using batch program modules for both batch and on-line file management may cause the inquiries to go through unnecessary routines to obtain the required information.

RECOMMENDATION 4

PROGRAMS SHOULD BE DESIGNED AND WRITTEN TO BEST CONFORM TO THE MODE OF OPERATIONS.

One change which could make a big improvement in CBI's and Revenue's response time, as well as, reduce processing time would be the discontinuation of CBI's practice to continue to que (store on disk) inquiries for Revenue's computer even after Revenue's computer is no longer available for processing.

RECOMMENDATION 5

CBI SHOULD CHANGE ITS PRIMITIVE MODE OF PROCESSING INQUIRIES TO THE DEPARTMENT OF REVENUE'S COMPUTER, WHEN THE COMPUTER IS NOT AVAILABLE FOR PROCESSING.

A more practical management approach would be to establish a short period of time (5 to 10 minutes maximum) to que the transaction when Revenue's computer was temporarily unavailable and then store only transactions which would still be valid for processing. CBI transactions should be processed in priority sequence with the more critical inquiries having high priority and ready access to the computer. In addition, the present data communications interface between CBI's and Revenue's computers is low speed and should be upgraded to higher speed lines and modems.

Revenue could do more in improving the computer to computer interface with CBI and improving their own terminal response time to Driver License Offices. The present on-line drivers license inquiry computer program processes transactions in a single-thread mode resulting in degrading the response time for all on-line users and increasing CPU utilization.

RECOMMENDATION 6

THE ON-LINE DRIVERS LICENSE PROGRAM SHOULD BE CHANGED TO A MULTI-THREAD PROGRAM WHERE MORE THAN ONE TRANSACTION AT A TIME COULD BE PROCESSED.

The size, complexity and efficient coding of computer programs has a direct effect on the CPU utilization and terminal response time.

The previous recommendations were concerned with organizational and operational considerations which must be implemented regardless of what hardware and software the department utilizes. The approach to implementation for the majority of these recommendations is by phasing out these outdated practices. This approach does not result in short term benefits but should produce long term savings through the increased productivity and performance.

TECHNICAL CONSIDERATIONS

Revenue's data processing has reached a stage in their development where changes need to be made to update their software to the State-of-the-Art. The Department is losing on-line data entry production hours due to poor terminal response time and systems availability. Service being provided to CBI and other on-line users, such as, drivers license and taxation, is below the established standard for this type of processing. This deteriorating service, coupled with the present high CPU utilization of the on-line computer, an application workload projected to exceed the current available computer processing hours in fiscal year 80-81, and the department's accelerated direction to on-line terminal update of master files may result in overextending the capability of the current Disk Operating System (DOS).

The migration to a full operating system (OS) should provide the capability to better manage the resources, increase system throughput, improve security, reduce operator involvement, and improve productivity of operation personnel.

RECOMMENDATION 7

REVENUE SHOULD MIGRATE TO A FULL OPERATING SYSTEM.

The upgrade to a full operating system provides the Department the opportunity to reduce 4.0 FTE from their operations staff and the capability to provide computer backup between State computer facilities for critical applications.

COMPUTER BACKUP

The parochial role where data processing personnel were responsible for all the processing activities has evolved into bringing the computer to the end user via data communication terminal. This on-line mode of processing has created new technical problems for data processors to solve. The potential for prolonged periods of computer systems downtime may impair the end users ability to meet deadlines, to provide adequate service to their general constituents, and create non-productivity hours among employees.

The Department of Revenue Computer Center and the General Government Computer Center make up a large percentage of the State's administrative processing. The loss of either one of these computer centers during critical processing time would result in a very high risk for the State. The State's ability to account and control for revenues collected, reconcile bank accounts, create warrants, produce the "Long Bill", or provide service to the law enforcement agencies will be greatly reduced if either computer is inoperable for long periods of time.

RECOMMENDATION 8

STATE COMPUTER CENTERS NEED TO DEVELOP A FORMAL RECOVERY ("DISASTER") PLAN IN THE EVENT OF A DISRUPTION OF SERVICE FOR ANY SIGNIFICANT PERIOD OF TIME.

The ability to recover protects against the widest set of hazards, including many that cannot be anticipated or prevented. Physical separation of the primary computer center and the backup computer center ensures that both locations will not be crippled by the hazards or prevailing conditions. The benefits of physical separation can be further enhanced by obtaining electric service from separate substations and avoiding use of common communication exchanges in communication-oriented systems.

Once the Department of Revenue has completed the migration to a full operating system and data communication facilities have been developed, then the State has reached the point where critical on-line applications could be considered for backup processing.

RECOMMENDATION 9

REVENUE'S COMPUTER CENTER AND THE GENERAL GOVERNMENT COMPUTER CENTER SHOULD BE WORKING TOGETHER TO MOVE IN THE DIRECTION OF PROVIDING BACKUP CAPABILITY FOR EACH OTHER FOR CRITICAL APPLICATIONS.

HARDWARE CONSIDERATION

Revenue's present computer configuration of a loosely, coupled dual 370/145's is classified as intermediate size computers. Revenue's present computer system does not provide the needed resources to provide backup capability for the General Government Computer Center's critical on-line applications.

In Fiscal Year 80-81, Revenue's projected application workload requirements will exceed the projected available processing hours for the present computer configuration. Revenue's on-line computer exceeds the established practical control limits 46% of the time on prime shift. These short falls in computer power and deteriorating service, coupled with the need to update their operating system to the state-of-the-art processing indicates that Revenue should upgrade the present computer configuration to a large scale computer.

RECOMMENDATION 10

REVENUE NEEDS TO UPGRADE THEIR PRESENT COMPUTER CONFIGURATION TO A LARGE SCALE CENTRAL PROCESSING UNIT (CPU).

The computer upgrade should be compatible with the existing software and input/output (I/O) devices, and should be a single central processing unit (CPU). The installation of a single CPU allows the Department the opportunity to reduce an additional 4.0 FTE from its operating staff. Based upon the hardware monitor analysis, a single CPU should provide better cost/performance than a loosely, coupled dual CPU in a shared I/O environment.

FINANCIAL COMPUTER CENTER

The Financial Computer Center concept was an outgrowth of the 1977 ADP Master Plan and was conceived by data processing. This concept consists of transferring the central activities of accounting, treasurer, personnel, payroll, purchasing and budgeting to the Department of Revenue's Computer Center.

Revenue's immediate requirements to develop new applications for cash management and accounts receivable coupled with the additional need to update the computer operations to the state-of-the-art processing makes the modification and transfer of these central systems a high risk and more costly at this time. In addition, the transfer of these applications could hinder the progress of the Department of Personnel in the development of the personnel system on a data base management system and could impede Division of Accounts and Control, Department of Personnel and the Office of Planning and Budgeting progress in interfacing the present central systems and in defining future requirements and needs.

RECOMMENDATION 11

DELAY THE IMMEDIATE IMPLEMENTATION OF THE FINANCIAL COMPUTER CENTER AND BEGIN TO PLAN AND DEFINE THE FINANCIAL MANAGEMENT SYSTEM.

The planning period gives the State the opportunity to develop data communications network to support the financial activity and to assess the progress made by the central agencies in developing a financial management information system.

In summary, to do nothing, accomplishes nothing! A detailed implementation plan needs to be developed. The plan should lay out the task to be performed, the schedule to be followed, and the assignment of personnel responsible to carry out the task.

RECOMMENDATION 12

THE DEPARTMENT OF REVENUE, WITH THE ASSISTANCE OF THE DIVISION OF ADP, SHOULD DEVELOP A DETAILED IMPLEMENTATION PLAN FOR THE DEPARTMENT OF REVENUE TO MIGRATE TO A LARGE SCALE COMPUTER AND A FULL OPERATING SYSTEM.

During the implementation of the plan, written weekly status reports need to be produced to inform management of the project's progress.

APPENDIX

EXHIBITS

The Appendix contains exhibits that are referenced in the preceding text.

EXHIBIT A - Relative Computer Power

EXHIBIT B - Department of Revenue Organization

EXHIBIT C - Computer System Configuration and Data Communication Network

EXHIBIT D - Current ADP Applications

EXHIBIT E - Division of ADP Computer Service Level Standards

EXHIBIT F - Department of Revenue Computer Downtime

EXHIBIT A

RELATIVE COMPUTER POWER

The chart exhibits on the following pages were developed from industry publications and were used within this document to determine the size of computers necessary to handle the projected workload developed by the Task Force.

On Exhibit A-2, the IBM 370/145 is used as a base (given a value of 1:1 relative power). The down time/maintenance figures are based upon the actual historical averages of Revenue's facility and was determined to be the best figures for the proposed new equipment. Also on Exhibit A-2, it was determined that only 85% of any computers relative power can be achieved without degradation to the actual work being performed. This determination was made by examining the performance of existing processors when the actual processing unit exceeds 85%. The industry standard bears out that major vendors use 80% as the point of maximum utilization.

On Exhibit A-3, the central processor unit hours are again adjusted to reflect the additional overhead created by coupling two processors to share common peripherals. Based upon historical results of a hardware monitor analysis of the two coupled 145 processors at the Division of ADP, with the 145 single processors at Social Services, and Colorado University, it was determined that an approximate 10% degradation occurs. The problem program state calculation is based on the average estimated ratio of supervisor/problem program within existing facilities.

Exhibit A-4 portrays the projected relative power capability of equipment for various levels of problem program state requirements and provides a method for classing computers.

Computers were classed based upon their individual relative power capacity and, when coupled with a second processor, the combined relative power capacity. The purpose of classing the various processors and combination of coupled processors was to provide an easy reference for comparison of relative power. Class I processors are the smallest ones considered in this study and include those processors that provide up to 9,853 hours per year of problem program state relative power. Class II processors would provide up to 18,800 hours per year of problem program state relative power. Classes III, IV, V, and VI, would provide problem program state relative power of up to 27,500 hours, 36,300 hours, 45,300 hours and 54,000 hours respectively.

In the preceding text, the Department of Revenue's ADP application workload requirements, stated in annual CPU processing hours required, are compared to the various classes of computer's relative power to determine the computer class needed to process the Department's workload.

EXHIBIT A

CONFIGURATION COMPARISONS
FOR
SINGLE CENTRAL PROCESSORS

MACHINE	COST	RELATIVE POWER	TOTAL AVAILABLE HOURS PER YEAR	AVAILABLE HOURS AT 85%
135	144,804	.5:1	4,261	3,623
135III	258,000	.65:1	5,540	4,709
145	278,196	1:1(BASE)	8,523*	7,245
145III	298,392	1.35:1	11,506	9,780
148	279,600	1.35:1	11,506	9,780
158	487,968	2.3:1	19,603	16,663
3031	330,000	3.2:1	27,274	23,184
168	948,000	6.35:1	54,121	46,005
3032	616,320	7.2:1	61,365	52,164
3033	844,800	12.25:1	104,406	88,751

	HOURS
24 hours X 365 days	8,760
Less: Down time/Maintenance	237
BASE	8,523*

Total available hours per year is computed by multiplying the base hours of 8,523 by the relative power for each machine.

Available hours at 85% is computed by multiplying the total available hours per year by 85% or .85.

EXHIBIT A

CONFIGURATION COMPARISONS
FOR
COUPLED CENTRAL PROCESSORS

PROCESSORS	CPU HRS PER YEAR AT 85%	CPU HRS PER YEAR COUPLED @ 90% EFFICIENCY	PROBLEM PROGRAM STATE @ 50%	CLASS
135/145	10,868	9,781	4,891	I
135III/145	11,954	10,759	5,380	I
135/145III	13,403	12,063	6,032	I
135III/145III	14,489	13,040	6,520	I
145/145	14,490	13,040	6,520	I
145/148	17,025	15,323	7,662	I
145III/148	19,560	17,604	8,802	I
158	16,663	-	8,332	I
158/145	23,908	21,517	10,759	II
158/148	26,443	23,799	11,900	II
158/158	33,326	29,993	14,997	II
3031	23,184	-	11,592	II
3031/145	30,429	27,386	13,693	II
3031/148	32,964	29,668	14,834	II
3031/158	39,847	35,862	17,931	II
3032	52,164	-	26,082	III
3032/145	59,409	53,468	26,734	III
3032/148	61,944	55,750	27,875	IV
3032/158	68,327	61,944	30,972	IV
3031/3031	46,368	41,731	20,866	III
3032/3031	75,348	67,813	33,907	IV
3032/3032	104,328	93,895	46,948	VI
3033	88,751	-	44,376	VII

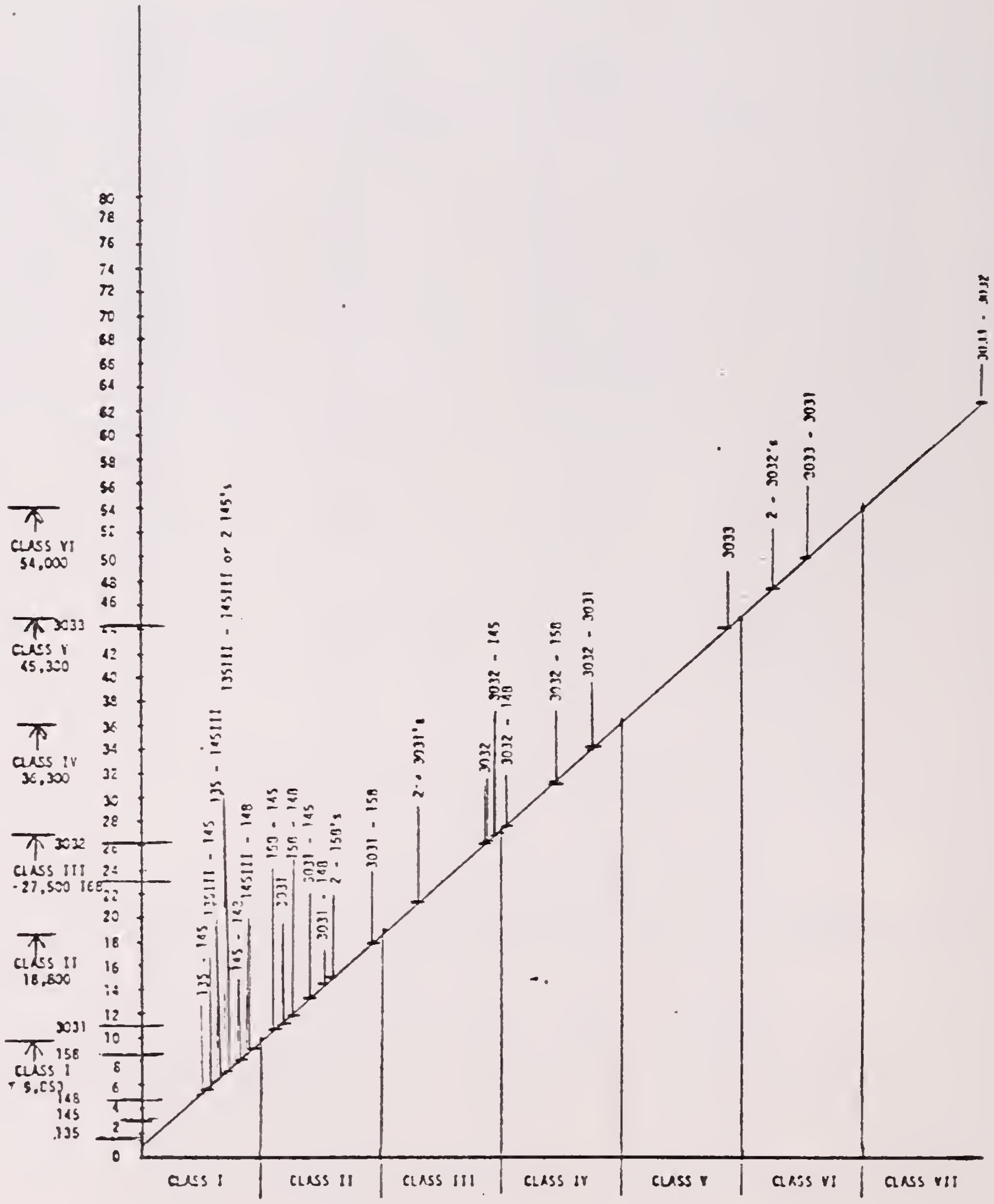
Central Processor Unit (CPU) hours coupled at 90% is computed by multiplying the CPU hours for coupled machines at 85% by 90% or .90.

Problem program state is computed by multiplying the CPU hours coupled at 90% (or CPU hours at 85% if single processor) by 50% or .50.

EXHIBIT A

COMPUTER CLASSES

Based on 85% Availability
of Processing Power and Running
in Problem Program State 50%.



DEPARTMENT OF REVENUE ORGANIZATION

The Department organizational structure and the relative position of the Division of Administration/Data Processing within the Department is depicted on Illustration-1. A more detailed view of the Data Processing organizational structure is depicted on Illustration-2.

EXHIBIT B

ILLUSTRATION-1

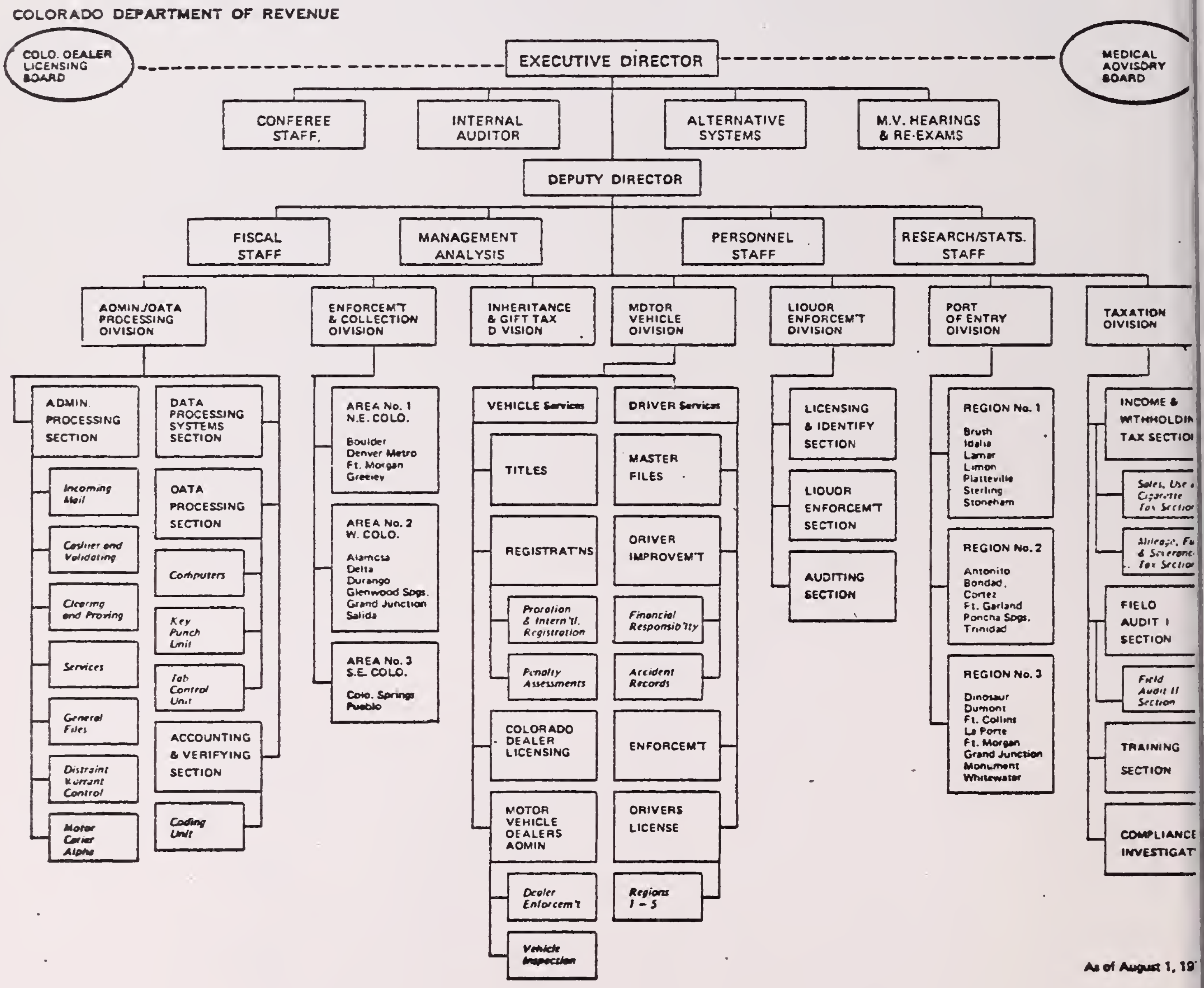


EXHIBIT B

ILLUSTRATION-2

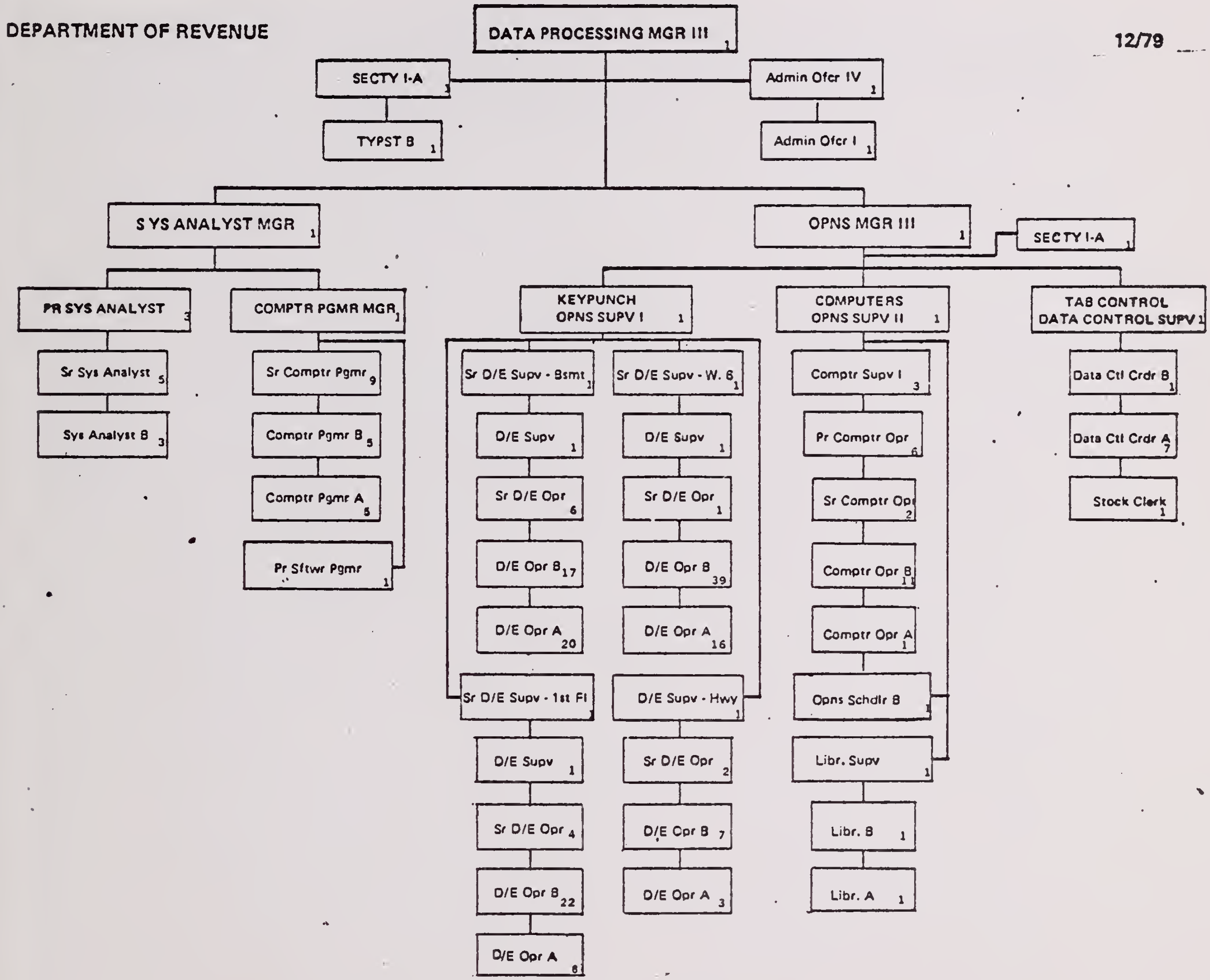


EXHIBIT C

COMPUTER SYSTEM CONFIGURATION AND DATA COMMUNICATION'S NETWORK

The Department of Revenue's computer system configuration of a loosely coupled dual IBM 370/145's sharing input and output devices is depicted on Illustration-1. The data communication's network supported by the computer configuration is reflected on Illustration-2.

EXHIBIT C

ILLUSTRATION-1

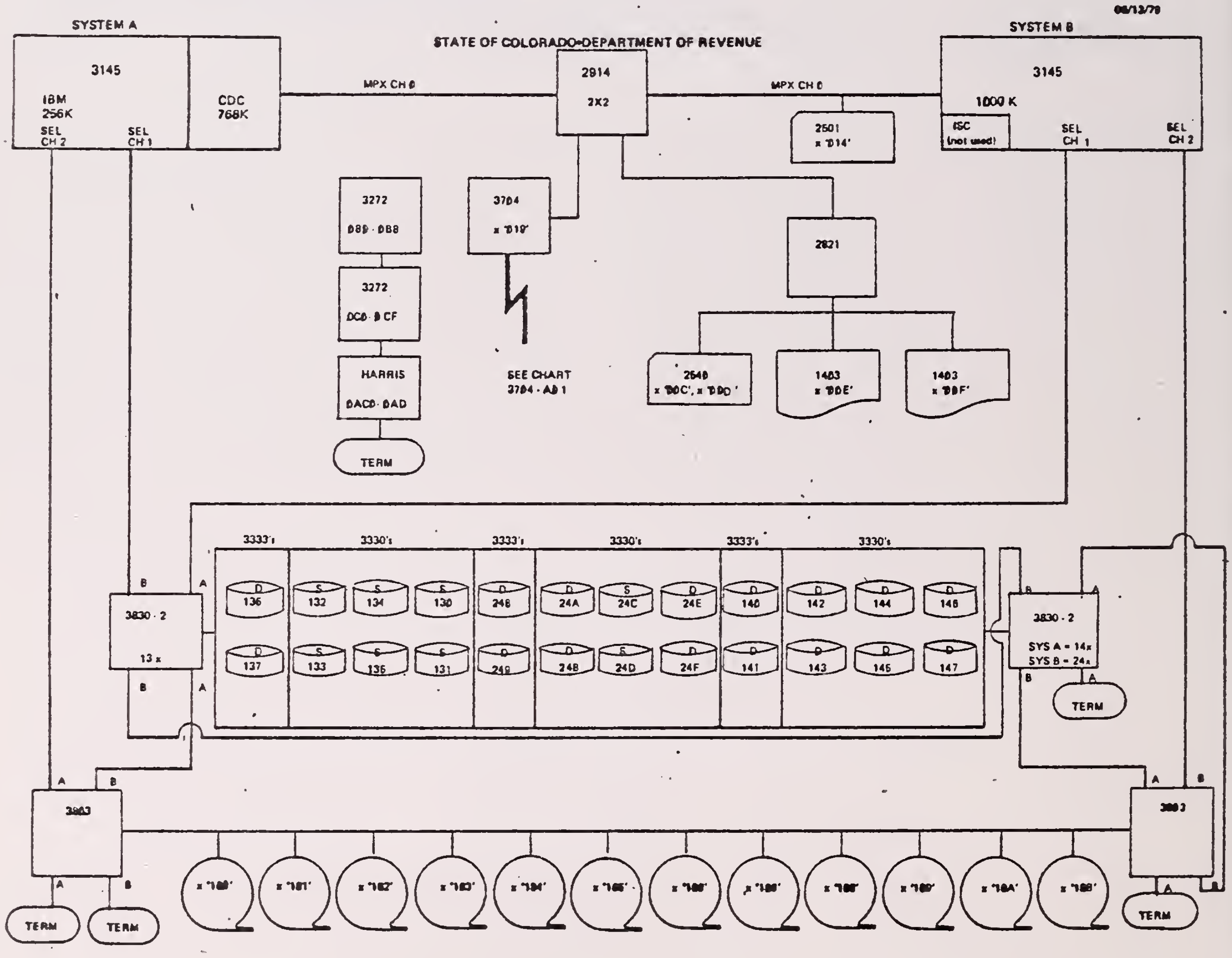


EXHIBIT C

ILLUSTRATION-2

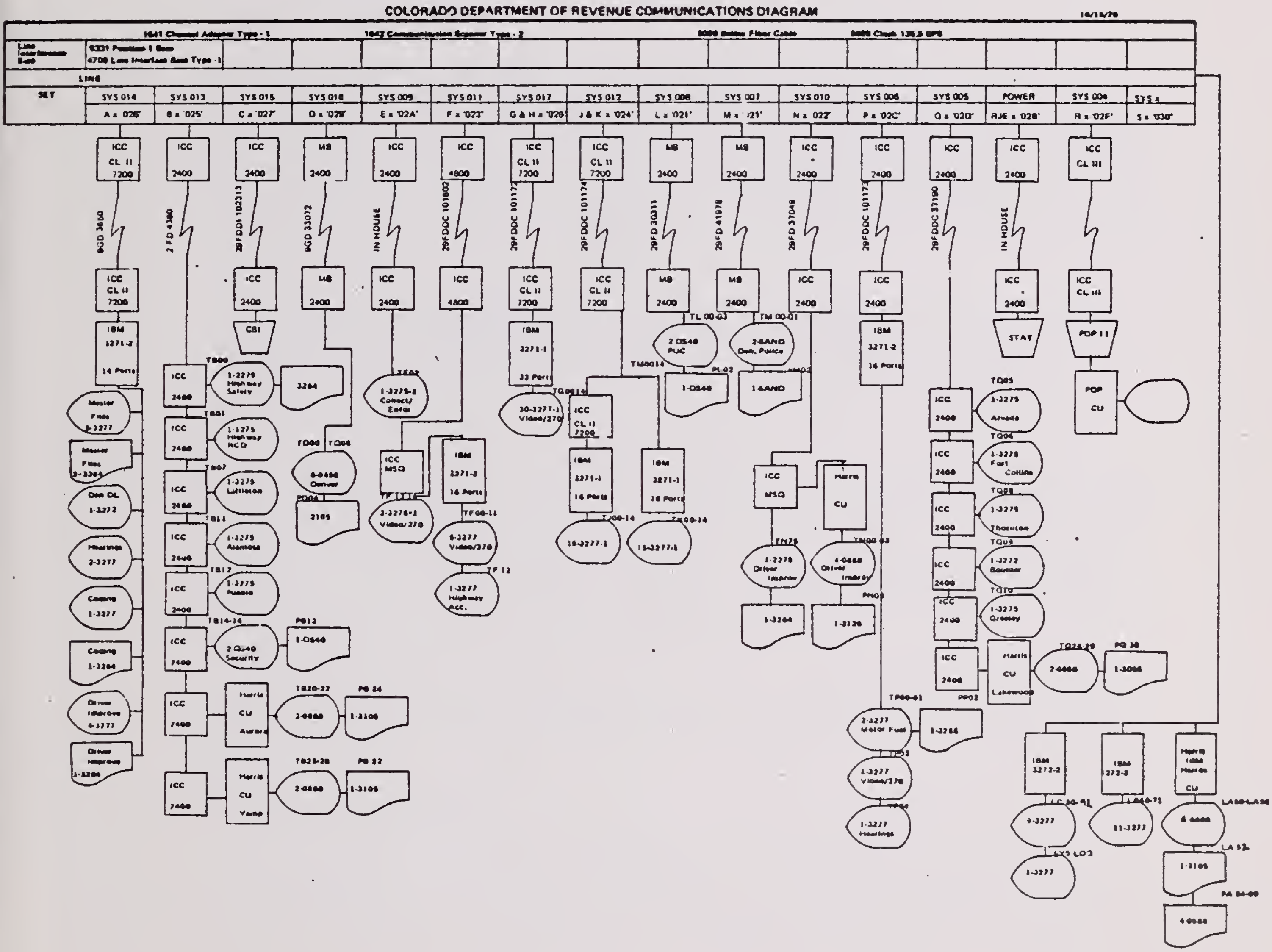


EXHIBIT D

CURRENT ADP APPLICATIONS

The Department of Revenue's data processing supports the following ADP applications:

1. TAXATION - MAJOR TAX

   The Major Tax Accounting System is used to record, post and audit the tax collection transactions. The system provides processing for 42 different taxes, licenses and fees. In addition to the monetary transactions, the system is used to provide tax statistical information, account transcripts, prepare fund reports and identifies delinquent and distraint accounts. The system also analyzes accounts and prepared tax return forms, licenses and permits.

   The system is disk oriented now and the plans are to (a) maintain the files in a production environment, (b) modify and update the system as the statutes and needs require, (c) use the files to develop cross reference and checking for accounts receivable as against refunds.

   For '80-'81, the most significant objective that can be worked on for this system is to develop and implement a plan which would allow the daily transactions to be entered on-line. The on-line entry of transactions would provide up-to-date account data for the Taxation Davision. The on-line update concept also would allow immediate update to an accounts receivable file, delinquency file, distraint file, fund status file and statistical file.

   Data communications at the present time involves 20 local terminals and 5 local printers. Discussion has occurred which would involve placing inquiry terminals in district offices.

2. TAXATION - INCOME TAX

   The Income Tax Accounting System is used to record, post and audit the Individual, Corporation, Fiduciary and Partnership income tax transactions. In addition to the monetary transactions, the system is used to provide information for numerous statistical reports.

Income tax refund checks are created by this system for those taxpayers who's return shows an overpayment of tax for the year.

The system will be disk oriented by July 31, 1979. The plans are to (a) maintain the files in a production environment, (b) modify and update the system as the statutes and needs change, (c) use the files to develop cross reference and checking for accounts receivable vs. refunds.

For '80-'81, the most significant objective for this system will be to develop and implement a plan which would allow for on-line entry of the daily transactions. The on-line entry of transactions would provide up-to-date account data for the Taxation Division. The on-line update concept would also allow immediate update to an accounts receivable file, delinquency file, distraint file, fund status file and statistical files.

Data communications at the present time involves 4 local terminals and 1 local printer. Additional terminals and printers would be required to implement the on-line transaction concepts.

3. DRIVERS LICENSE

The Drivers License information system is used to record, post and edit driver record information. The system determines driver eligibility, identifies drivers who are eligible for hearings and suspensions.

As an information system, inquiry response is provided to 13 drivers license offices with video terminals. Driver record information is also provided to the Master Files Section in the form of printed histories which show all tickets and licenses on a drivers record. The information in the system is stored on-line on magnetic disks. Access to the information is provided by Video terminals. A telephone line is connected between the Department of Revenue computer and the CBI system to access driver information for law enforcement agencies.

Ten more Drivers License offices are to be provided a terminal in '80-'81, for access to the driver data and to determine applicant eligibility.

Six Drivers offices will be provided intelligent terminals so that data on all transactions can be captured and transmitted to the main computer for Master file update. These 6 offices will also be able to determine applicant eligibility.

Data communications at the present time involves 13 Drivers License offices around the metropolitan area and will require telephone line service to the new offices to be implemented in the future.

4. MOTOR VEHICLE REGISTRATIONS

The Motor Vehicle Registration information system is used to record, balance, post and edit the Motor Vehicle Registration information. The system has a dual function. One, it provides accounting and control for the County Clerks who register the vehicles and two, it provides on-line information for the Department and CBI inquiry systems.

Within the accounting system, the periodic reporting of registration accounting information from the counties is balanced, edited, audited and posted to the Master File. Audit lists and recap reports are sent back to the counties.

The registration information in the system is stored on-line on magnetic disks. Access to the information is provided by Video terminals. A telephone line is connected between the Department of Revenue computer and the CBI computer. This line is used by CBI to access Driver/Vehicle information for law enforcement agencies.

Plans are still being developed which will expedite the renewal process for those counties which have their own computer capability. The number of counties submitting their transactions on magnetic tape will continue to increase. Tape data makes this system more responsive to timely file updates.

In '80-'81, it is planned that we could update the files on-line at the same time we enter the new registration information. This type of function would limit the data entry to the video terminals at West 6th Avenue which are under control of the processor. In an on-line environment it would also be desirable to balance the daily business from a terminal to a disk file.

Several more counties are interested in providing their weekly reporting on magnetic tape. We will continue to encourage this effort and accept the reports on tape. One county is also interested in trying to submit their business to the Department daily, over a telephone line hookup to our CPU.

Data communications for '80-'81, would not be broadened beyond the current service for inquiry. It will probably be expanded to at least one county in order to develop a daily reporting of transactions.

5. DISTRAINT WARRANTS

The Distraint Warrant system is used to identify and control the accounts who have not paid their respective taxes in previous months.

A program in the Distraint Warrant System analyzes the Major Tax Accounting file once a month and determines the accounts who are delinquent. The delinquent information is written on magnetic tape and processed by the DW system.

Weekly, the requested DW's are processed and Port of Entry Bulletins are prepared.

Daily, the cleared and cancelled warrants are posted to the DW Master File and cleared reports are prepared.

This system also creates an on-line DW inquiry file for the Collection and Enforcement Section.

The '80-'81, effort for improvement in the Distraint Warrant system would be to provide each of the district offices with a terminal so that they could access the on-line information about errant taxpayers. On-line delinquency and distraint files would be developed and maintained.

Data communications would have to be developed for 11 district offices throughout the State.

6. ACCIDENT REPORTING

The Accident Reporting is used to record accident record information and create statistical reports for the National Safety Council, Highway Department and the State Patrol.

All of the investigated accident reports are entered into the system and are used for the statistical analysis. Non-investigated accident reports are recorded for reference purposes.

Accident record statistics are also compared to violation statistics in order to provide the patrol with potential problem locations.

The system provides the Highway Department with on-line inquiry information regarding accidents according to road code data.

For '80-'81, funds will be requested to obtain a software package for generic searches. Highway safety related inquiries are becoming so numerous and complicated that we are unable to meet the demands and time frames.

There are some activities being conducted which may cause the accident report to be redesigned. If so, there will have to be a major change in the present processing system. Data communications is limited to a single line to the Highway Department.

7. LIQUOR WHOLESALER SYSTEM

The function of this system is to insure that the monthly tax paid to the State by the wholesale liquor dealers is correct and in accordance with the amount of liquor shipped into the State by the various distillers. To accomplish this, the system matches the amount of units and tax owed from the wholesaler reports against the units and calculated tax reported by the distillers on their invoices, any discrepancies are flagged for action by the Liquor Division. The same system will be applied to beer wholesalers (distributors) and brewing companies.

The liquor system is under review at this time. A total new systems requirement is expected to result from the review at which time a system will be designed and equipment ordered to support the new system in '80-'81.

Data communications involves a single terminal within the annex that serves the Liquor Division.

8. MOTOR FUEL REFUNDS

The Motor Fuel Refund System is used to record, post, audit and print refund warrants for motor fuel tax accounts. The major function of the system is the control and issuance of refund warrants.

This is a tape oriented system that is updated monthly.

The continued processing of refunds is the only function planned for '80-'81.

9. INHERITANCE TAX

The Inheritance Tax System is used to record inheritance tax accounting transactions and provide weekly and monthly accounting reports. This is a tape oriented system which is updated weekly. The Master file is contained on a reel of tape.

The system is maintained with 11 programs and a few standard utility programs. A completely new overall system is being designed in '79-'80, for the Inheritance Tax Division.

For '80-'81, the new system is expected to need 2 or 3 terminals within the Annex (no remote sites) with which to create, update, analyze, bill, inquire and provide management information regarding Inheritance accounts.

10. PATROL TICKETS

The Patrol Ticket system is used to provide the State Patrol information with respect to the source and disposition of tickets. The system is maintained with 23 programs. There are no anticipated changes for this system at this time.

11. MOTOR FUEL BILLS OF LADING

The Motor Fuel Bills of Lading system provides for the monthly recording of bulk sales of gasoline by individual BOL's to those accounts which are liable for Motor Fuel Tax.

Reports generated are the listing of each Distributor's or Refiners BOL's for the month by supplier. The listings are used by the Auditors to check against the DR57's, distributors or refiners monthly report of Motor Fuel Tax. There are no anticipated changes to this system for '80-'81.

12. PORT OF ENTRY

Data processing provides micro-fiche lists of Tax Distraint Warrants to all of the ports. The ports use a mark sense document (GTM-18) as the port clearance form. Data processing equipment is used to read the GTM-18 form and process the data into audit lists. The lists provide the GTM tax auditors with account status information.

The port clearance forms provide a control on the collection and reporting of Gross Ton Mile and Special Fuel Taxes.

There are no communications connections to the ports and there are no major enhancements planned for '80-'81.

13. PURCHASE ORDERS AND VOUCHERS

This system uses invoices from fiscal office to create input records for Central ADP System. There records are edited and an edit list is produced for the fiscal office to check. All errors are rejected and all good transactions are written onto a tape for the Central ADP System.

The vouchers are printed for Fiscal Office.

Major changes are planned for this system in '80-'81.

14. ABL VARIANCE REPORTING SYSTEM

This system uses all transactions for the month from the Central ABL Systems Tape and summarizes it by sections in P.O.T.C. for the master file update. Reports are produced by section showing the money plan for each section. The reports are sent to the Fiscal Office for distribution. Major changes are planned for this system.

15. PRORATION/SPECIFIC OWNERSHIP TAX/IRP SYSTEM

This system provides for the proration of Motor Vehicle Registration fees for the commercial carriers and the Non-Colorado based carriers.

The system is tape oriented. Batches of data are received from the proration section, keypunched and posted to a master file. Data is then extracted for the printing of statements and receipts. The receipt is to be used as a cab card in each tractor power unit to show that registration fees have been paid in Colorado. It also shows what percent of travel was claimed in Colorado.

This system is becoming very difficult to operate in a timely manner. The service to the taxpayer has become very unsatisfactory. It is planned in '79-'80, to provide the proration section with an on-line terminal system whereby most of the counter business could be conducted quickly and provide good service. For '80-'81, the system will undergo a complete analysis and design so that it will be responsive to the needs of the division.

There is a requirement for the Motor Vehicle Division to participate in the International Registration Information System (IRIS) probably in the '80-'81 years. Data communications will be required between the Annex and the Motor Vehicle Division at West 6th Avenue. Probably 3 or 4 terminals and one printer.

16. GENERAL ADMINISTRATION SYSTEMS

The General Administration Systems consists of program support for the Fiscal Office and the Personnel Office.

Personnel reports concerning staffing pattern, sick, annual, promotion eligibility etc., are prepared for the Personnel Office. In the Fiscal Office, purchase orders, vouchers, budget, payroll, position cost, etc., reports are prepared. There are specific plans to change most of the systems to an on-line environment.

17. DRIVER IMPROVEMENT SYSTEM

The Driver Improvement Section has a minicomputer. The administrative processing for drivers who are pending restraint actions accomplished machine.

File folders, notices of suspensions, hearings, reinstatements, etc., are prepared, managed and processed for each driver's case history. Information exchange between the mini and the main files on the main computer is by means of magnetic tape.

Plans for '79-'80, are to seek Federal Funds to be used to connect the two computers thru telephone lines. This will enable the mini, located at the Motor Vehicle Division, to communicate directly with the main computer at the Annex. Of course, timelier and more responsive information will be available to administer the Driver Improvement System.

Planning for the '80-'81 period involves the further enhancement of the interface between the mini and big computers.

EXHIBIT E

DIVISION OF ADP'S
COMPUTER SERVICE LEVEL STANDARDS

The following are computer service level standards developed by the Division of ADP and published in their 1977 ADP Master Plan. These standards provide a means for Departments, Institutions, and Agencies to measure their performance and establishes operational objectives to be met in providing computer service.

STANDARD SERVICE LEVELS SHOULD BE USED STATEWIDE IN DEVELOPING COST/ BENEFIT ANALYSIS FOR NEW SYSTEMS

- Prime Shift - 8:00 AM to 5:00 PM (95% reliability)

Priority 1 - On-line (interactive) applications where full-time operators are employed whose high productivity would be lost by poor response time (less than 5 seconds).

Priority 2 - On-line inquiry applications where citizen information is being retrieved for agency and/or citizen inquiry and interactive program development (less than 10 seconds).

Priority 3 - On-line inquiry applications for management information (less than 20 seconds).

Priority 4 - Remote and local batch production jobs that require prime shift processing (1 hour plus processing time).

Priority 5 - Inquiry by counsellors, auditors, etc., for conduct of daily business (less than 45 seconds).

Priority 6 - Remote and Local Student batch jobs
- Students in beginning courses (less than 15 minutes).

- Students in advanced courses (less than 1 hour).

Priority 7 - Remote and local batch program compiles, tests (less than 1 hour plus processing time with 90% reliability; more than 1 hour increases programming labor costs.

- Second and Third Shifts (99% reliability)

Priority 1 - All on line (interactive) processing with the same response time as prime shifts.

Priority 2 - All regularly scheduled batch production jobs - by 8:00 AM

Acceptable service levels must be established statewide to determine cost justification for additional hardware and the feasibility of on-line systems, and to be able to measure responsiveness to the various users of ADP Services.

In the past year, much work has gone into determining appropriate service standards. Based on current user needs and consultation with industry and other State governments, the above standards were developed.

EXHIBIT F

DEPARTMENT OF REVENUE COMPUTER DOWNTIME

The following illustration breaks down each type of downtime experienced in the computer facility for the period of January 1, 1978 thru June 30, 1979 - a total of eighteen months.

ILLUSTRATION - 1
SUMMARY OF TYPE OF DOWNTIME BY HOURS

Type	No. of Times	Hours	Minutes
Disk	20	39	45
System Lockup	85	31	29
Air Conditioning	13	27	00
Power Failure (PSC)	14	18	59
C.M.I. Memory	4	15	32
C.P.U. Hardwait	34	12	25
System Down - cause unknown	4	8	4
C.P.U. Lockup	30	6	24
Electrical (building)	1	6	15
3704 Controller	2		51
Error in Supervision	4		45
Channel Lockup	3		43
Tape Control Unit	1		25
Card Readers	1		19
TOTAL DOWN TIME	212	168	56

9903

RECEIVED

MAY 1 8 2015

STATE PUBLICATIONS
Colorado State Library